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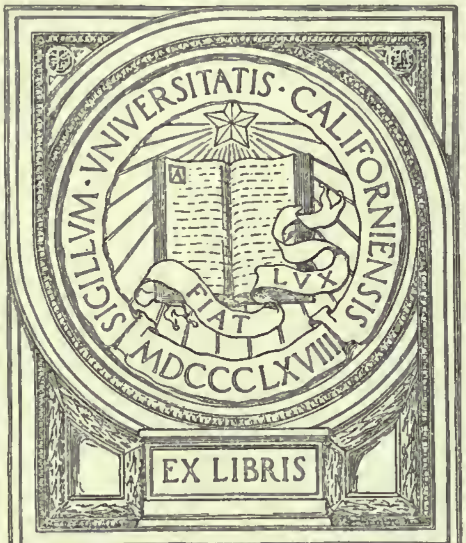

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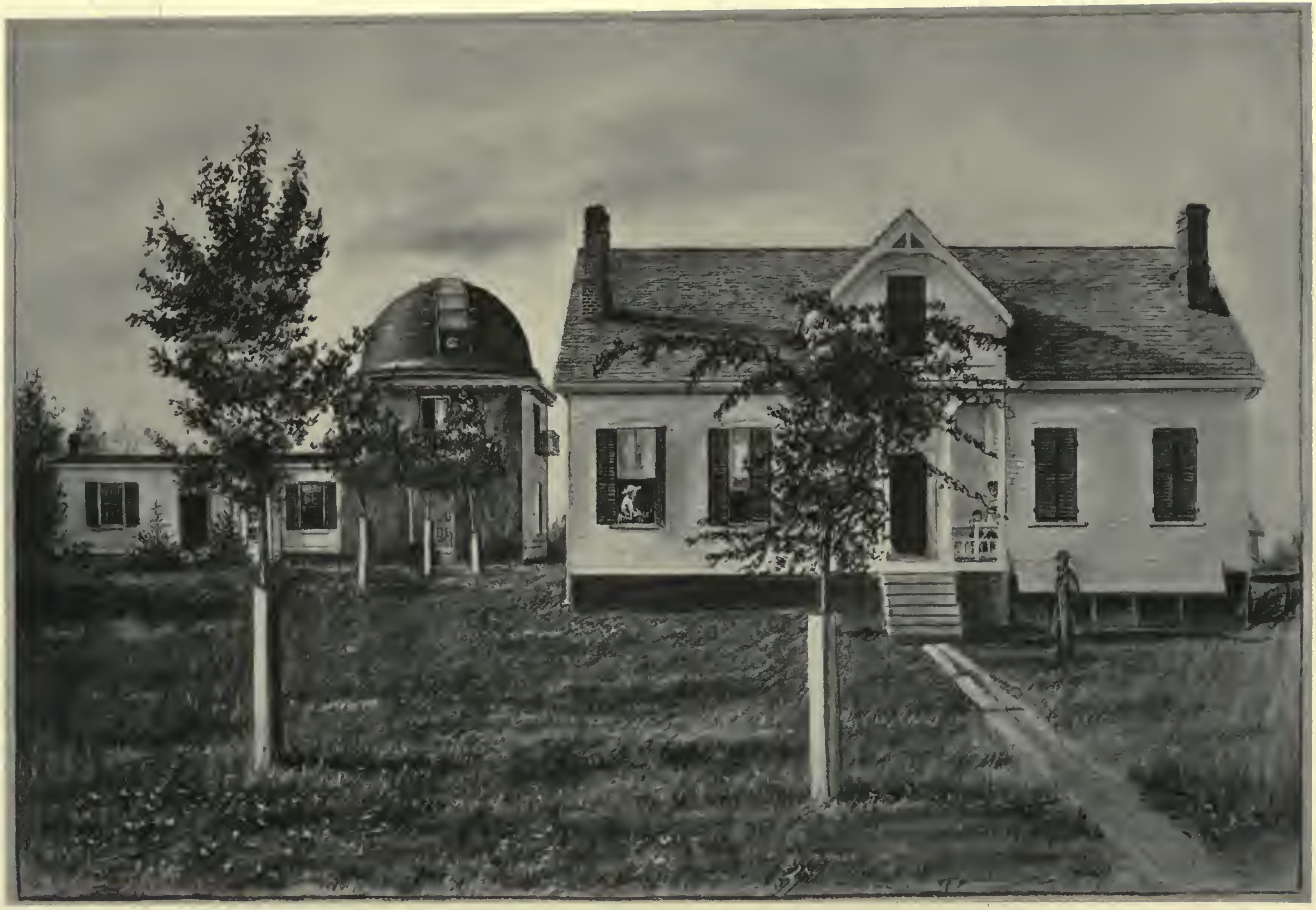

OBSERVATORY. RESIDENCE.

(FROM SOUTH LAWN.)

421

PUBLICATIONS

OF THE

MORRISON OBSERVATORY,

GLASGOW, MISSOURI.

No. 1.

CONTAINING DESCRIPTION OF THE INSTRUMENTS, AND DETAILS OF DETERMINATION OF
THE GEOGRAPHIC CO-ORDINATES OF THE MERIDIAN PIER, AND SOME
MISCELLANEOUS OBSERVATIONS AND NOTES.

UNIV. OF
CALIFORNIA

PREPARED FOR PUBLICATION BY THE DIRECTOR,
CARR WALLER PRITCHETT.

1885.

LYNN, MASS.:
PRESS OF THOS. P. NICHOLS.
1887.

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INTRODUCTORY NOTE.

THIS small Publication was intended originally, simply to give in detail the authority for the values of longitude and latitude in use at the Observatory. But the generous founder of the Observatory, Miss BERENICE MORRISON, having signified her willingness to bear the expense of a larger Publication, the Director has gone over the observing books, and selected such observations and notes, in addition, as most probably may be of some use to astronomers, while it may afford popular information to general readers. Hoping that the labor bestowed upon it may not be entirely in vain, he humbly submits it to the Public.

C. W. PRITCHETT,
Director.

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ERRATA.

[The publication of this work at so great a distance from home, has deprived me of the opportunity of a second revision, before the sheets were printed. I regret to find some errors still uncorrected. These I shall indicate below. — C. W. P.]

PAGE 2. Line 9 from bottom, for Township 46, read *Township 51;* and in line 2 from bottom, for Andrian, read *Audrain.*

PAGE 11. Line 8 from bottom, for moveable, read *movable.*

PAGE 19. Last line, under v, for 0.28, read *0.08.*

PAGE 23. Line 4 from top, for η Urs. Min., read η *Urs. Maj.;* also, in line 9 from top, column 10, for 39.67, read *39.76;* also, in line 17 from top, column 6, for 0.248, read *0.228;* also, in line 27 from bottom, column 5, for 0.271, read *0.274;* also, under June 19, between α Bootis and 5 Urs. Min. the observation of ϑ Bootis was omitted. The numbers of the observation in their respective columns stand as follows:

June 19 \| ϑ Bootis \| 9 \| 14 22 5.13 \| —0.143 \| 0.608 \| 0.000 \| 0.46 \| 5.59 \| 9.77 \| —55.82 \| —0.01

PAGE 30. Following line 13 from top, the following foot-note was omitted: "*We were first led to investigate this error from the discrepancy which became manifest through a comparison with some work of the U. S. Engineers of the Missouri River Commission.*"

PAGE 31. Line 13 from bottom, for Attached Thermometer $= T$, read $= T_a$; and Ext. Ther. $= T$, read $= T_e$.

PAGE 34. Observation of α Lyræ, column z, for 0° 32′ 54″.46, read *0° 32′ 54″.16.*

PAGE 44. No. 171, for 2.29 read (in column s), *2.29 (?).*

PAGE 46. No. 225, for L.l., read *L.L.*

PAGE 47. In lines 8, 9, 10 from bottom, for .2″, .4″, .3″, read respectively *0″.2, 0″.4, 0″.3.*

PAGE 58. Special phenomena for November, 1882, for herald, read *heralded:* also, special phenomena for May, 1883, for Tornado conditions indicated, read *Tornado conditions indicated, in advance, by barometer;* also, special phenomena for January, 1884, for Ther. 28°, read *Ther. 28° negative.*

PAGE 59. In column B for 1884-85, for 292.87, read *29.287.*

PAGE 90. Under Oct. 9, column Phase, for half on, read *half off.*

PAGE 95. Line 13 from top, for cengitur, read *cingitur.*

PAGE 100. Line 9 from top, for difference, read *differences.*

PAGE 103. In the naked eye view of Comet *Cruls*, on opposite page, for α Lyræ, read α *Hydræ.*

FOUNDING OF MORRISON OBSERVATORY.

HISTORIC OUTLINE.

The private studies of Mr. C. W. Pritchett furnished the original impulse to the founding of the Morrison Observatory. These studies were continued for many years under great disadvantages, and under the pressure of constant teaching. They served, however, on his part, to awaken a strong desire to become connected with a creditable astronomical observatory in Central Missouri. A knowledge of these facts gained the sympathy and aid of generous friends.

As early as 1858–59, Mr. Pritchett obtained release for a year, from his duties as Professor of Mathematics and Astronomy in Central College, Fayette, Missouri. The greater part of that year was spent at Cambridge, Massachusetts, in connection with the Observatory of Harvard College, then under the directorship of Mr. William C. Bond, assisted by his son, George P. Bond. During this residence, he formed the acquaintance of several gentlemen, whose counsels and instructions have been to him of life-long value. Among these were the Bonds, Prof. Benjamin Peirce, Prof. Jos. Winlock, Prof. Jno. D. Runkle and Prof. Asaph Hall, the last then assistant at the Harvard College Observatory.

Soon after his return to Missouri, initial steps were taken for a small Observatory, in connection with Central College; but these plans were frustrated by the civil war and consequent changes. After moving to Glasgow, in 1866, and the founding of Pritchett School Institute, the plan of an Observatory was renewed, and was warmly seconded by his friend, Rev. James O. Swinney, whose enterprise and liberality had founded the Institute. Steps were taken for an Observatory on the Institute grounds, and an eight-inch equatorial was ordered and actually finished by the Clarks. Materials were collected on the grounds for the piers and building, and a contract was partially made with Pistor & Martins, Berlin, for a meridian circle. At this juncture, unforeseen difficulties again occurred; and with much chagrin the Observatory was allowed to sink into forgetfulness.

At length, in 1874, encouraged by her known sympathy with his plans and studies, Mr. Pritchett made application for aid, by letter, to Miss BERENICE MORRISON, then residing, temporarily, at Hanover, Germany. In this letter he detailed his plan for a modest Observatory competent for scientific work. It contemplated an astronomer in charge with an annual salary of $2,000, an assistant at $1,000, and $500 for other expenses. To his great joy, Miss Morrison, by letter dated October 24, 1874, authorized the speedy building and equipment of the Observatory, leaving the construction of the building, and outfit of instruments, entirely in the hands of Mr. Pritchett, subject to the direction and control of her legal representative, Mr. James O. Swinney. A generous and manly letter from Mr. Swinney accompanied the letter of Miss Morrison, and made legal provision for the beginning of the work. Accordingly, early in the spring of 1875, a very desirable site was selected and secured for the Observatory. Plans and specifications for a plain, but suitable building, were drawn by Mr. Albert Stevens, Architect, Cambridge, Mass. They were minutely inspected and fully approved by Prof. Joseph Winlock, Director of Harvard College Observatory. Also, in March, 1875, a contract was made with Alvan Clark & Sons, Cambridgeport, Mass., for an equatorial instrument of large aperture, to be ready by January, 1876. In June, 1875, a contract was also made with Troughton & Simms, London, for a meridian circle, to be finished in eighteen months. At the same time a contract was made with Charles Frodsham, London, for a sidereal clock.

In July, 1875, work was begun on the building, the execution of the plans and specifications being under the charge of Mr. A. R. Johnson, of Glasgow, Mo. In December following the work was so far completed as to allow the mounting of the equatorial telescope.

OBSERVATORY SITE.

The Observatory is located on a lot of ground of two and one-half acres, donated by John F. Lewis and H. Clay Cockerill. The lot is within the limits of the S. E. quarter of Section 9, Township 46, Range 17, W. of the fifth principal meridian of the U. S. Surveys. The south front of the building stands two hundred and thirty feet north of the east and west line, between Sections 9 and 16. The situation is high, and commands the horizon in every direction. Two separate determinations have been made of its altitude above the sea level. The first was furnished in 1878, by H. W. Parkhurst, Division Engineer on the Chicago and Alton Railroad. It depends on the series of levels on the Wabash and Pacific Railroad from St. Louis to Mexico, in Andrian County; and on the levels on the Chicago and Alton, from Mexico to Glasgow. By this determination, the stone

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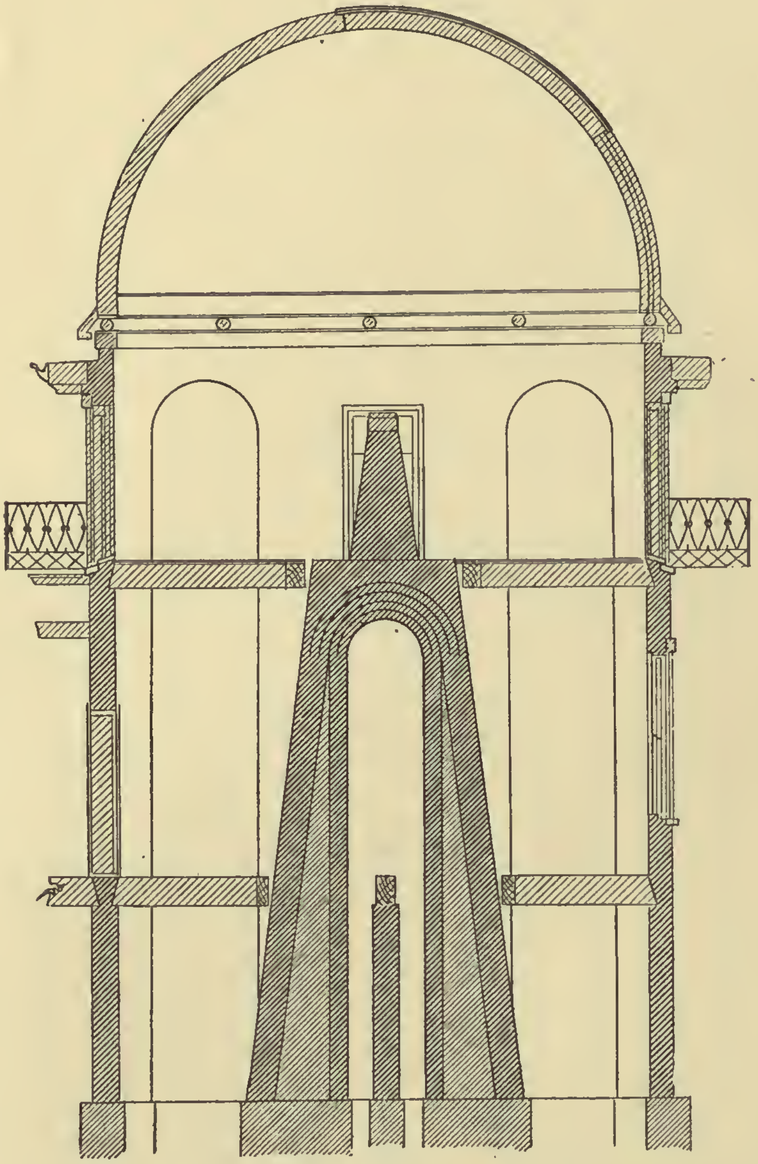

SECTION FROM EAST TO WEST. Scale: 1 Inch = 8 Feet.

sill of the south door of the equatorial room, is 327.20 feet above the St. Louis City Directrix. The second determination was made Nov. 24, 1884, by level party under Capt. D. W. Wellman, U. S. Assistant Engineer. Two independent lines of level were run from bench-mark $\frac{47}{3}$ at the Glasgow railroad bridge. The results gave 332.004 feet above the St. Louis City Directrix. Taking the altitude of the St. Louis City Directrix, 412.71 feet, the last determination gives the altitude of upper surface of stone sill of equatorial room, 744.72 feet above sea level.

GENERAL ACCOUNT OF THE BUILDING.

The entire front on the south is 65 feet. The eastern tower, for the equatorial, is of brick, and is 24 × 24 feet. Its walls are very thick, and below the surface the masonry is grouted with hydraulic cement, giving the foundations almost the solidity of unbroken stone. These walls extend 8 feet below the general surface. The inner surface of the walls is circular, thus causing near the corners great increase in thickness, and affording buttresses for the arches over each corner at the top. This arrangement gives at the corners circular recesses, in the observing room, which are of great practical use. The circular wall at the top is surmounted by a ring of dressed limestone, 10 inches wide, by 8 inches thick, laid in cement, and the separate blocks firmly tied together by iron clasps embedded in the rock with molten lead. On this stone ring is laid the first set of grooved iron plates, 8 inches wide, and 1½ inches thick. Another set of plates, symmetrical with the first, is firmly bolted to the lower sill of the dome, and between these plates at equal intervals six spherical balls of gun-metal, 7 inches in diameter, are placed, thus supporting the dome, and affording facility for turning it round. The tower is surmounted by a hemispherical dome 21 feet 10 inches in diameter on the inside. The entire dome and shutters were framed at Cambridge, Mass., under the direction of Mr. Albert Stevens. The circular rafters are of pine, 6 × 3 inches, their feet standing two feet apart on the sill. The inside of rafters is ceiled with smooth boards and painted. On the outside of rafters there is a ceiling of smooth pine boards, on which are placed the tin plates which form the roof. The shutters are covered with copper plates, are 2½ feet wide, and are in four sections. The two lower sections are hung with weights, and are raised or lowered from the floor by a rod of suitable construction. The two upper sections are raised and lowered by two pairs of endless chains, whose separate joints pass over toothed wheels, and are turned by a crank. The entire dome is readily revolved on the balls at its base by a gearing of wheelwork, acting on cogs projecting from the sill of the dome. The shaft carrying the gearing of wheels, and capstan for turning, all fit into one of the arched recesses of the observing room, and are entirely out of the way. The entire iron work for the dome was constructed by G. W. & F. Smith, 409 Federal Street, Boston. As the dome and shutters and the manner of working them are a duplication of those at the Harvard College Observatory, delineations of them may be seen in Vol. I., Annals of Harvard College Observatory, Figures 4, 5, 6, 8.

West of the equatorial rooms and connected with them, is a strong frame building. It consists of two main rooms, with a short hall between them, through which is the south entrance to both rooms. The east room is the transit circle room. Its general dimensions are 18 × 22 feet; but through the center of the alcoves it is 36 feet in length. Under both the transit and equatorial rooms is a basement. The west room is the computing and library room; and is the only one in the building where a fire is kindled at any time. The distance from floor to ceiling in these rooms is 10 feet. The roof is covered with tin. The shutters of the transit circle room are in four sections. They are $2\frac{1}{2}$ feet wide, and are raised and lowered from the floor by ropes passing over pulleys on the roof. These ropes are worked by capstan-wheels. By means of hinged shutters, the slits are continued down the sides of the building to the level of the instruments. These hinged shutters are very useful in obtaining collimation by day-light. In the library room are permanent cases for books and papers, a closet for the chronograph, and stands for telegraphic instruments.

PIERS FOR THE INSTRUMENTS.

These are all built of brick, and entirely insulated from the building and floors.

The Equatorial Pier. This massive structure has its base 10 feet below the surface. At the foundation it is $11\frac{1}{2} \times 11\frac{1}{2}$ feet. For the first 4 feet it is solid, being grouted with hydraulic cement. It is then carried up with gradually tapering double walls, tied together by intersecting walls, thus passing through both floors to the level of the observing floor. The top is finished with an arch, over which is a level base for the supporting shaft of the instrument. This shaft is constructed of Milwaukee brick, is 7 feet high, and at the base is $4\frac{2}{3} \times 3$ feet; at top it is $3\frac{3}{4} \times 1$ foot; on it rests a solid block of limestone, which is firmly fastened to the shaft, not only by the adhesion of cement, but by iron bolts anchored far into the masonry of the shaft. On this stone rests the iron stand, which Alvan Clark & Sons employ in mounting their equatorials.

The Transit Circle Pier. This pier stands in the center of basement of transit circle room. At the base it is $9 \times 5\frac{1}{2}$ feet, and at top it is surmounted by

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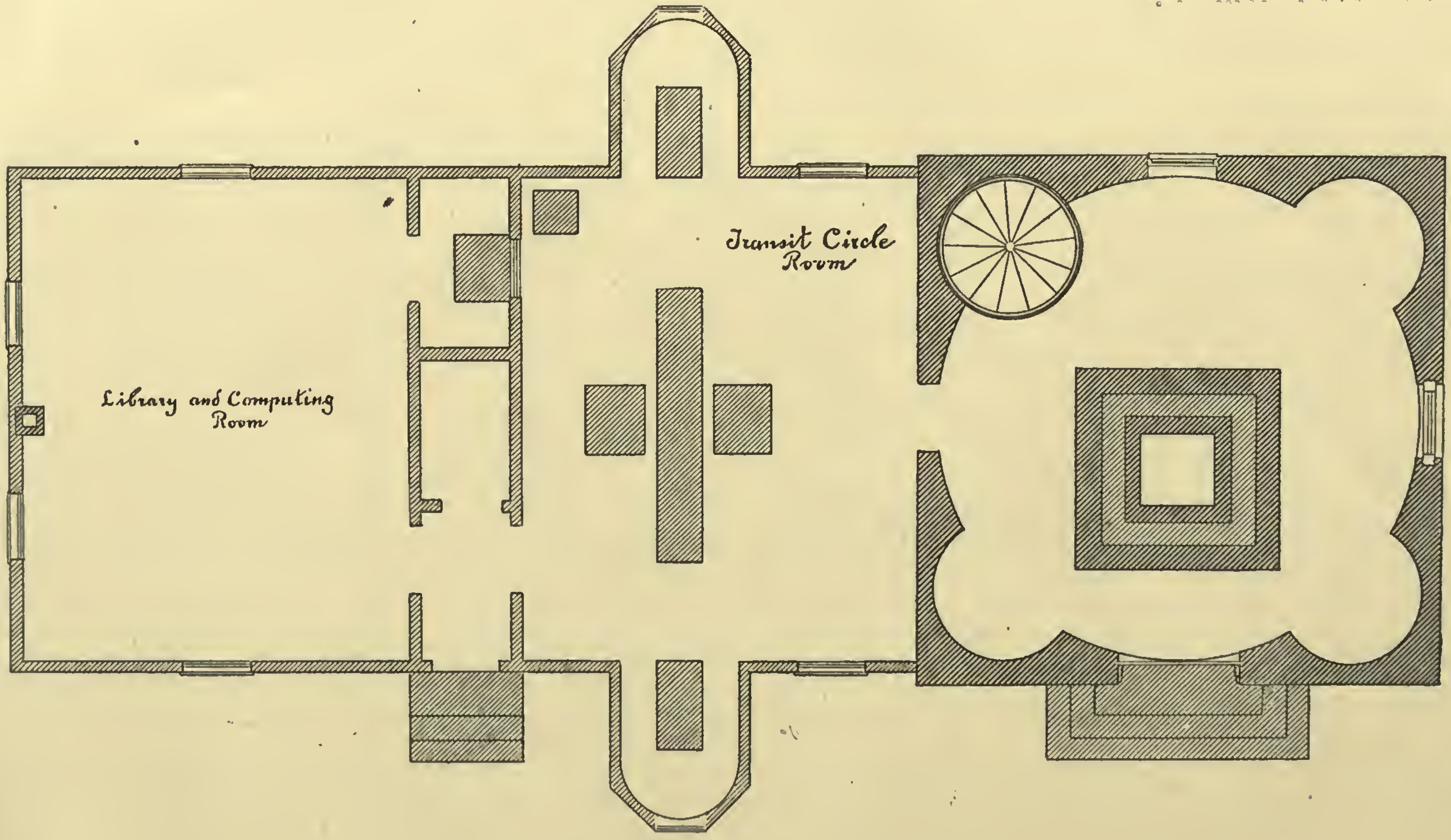

PLAN OF FIRST FLOOR. SCALE: 1 INCH = 8 FEET.

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very heavy blocks of solid limestone, which sustain the iron columns on which the transit circle rests. The masonry is grouted throughout, so that it is really a solid mass.

The Clock Pier. This pier is 4½ × 4½ feet at the base, in the basement of transit room. Just below the level of transit room floor, there is firmly planted in this pier a solid stone slab, weighing 1500 pounds, to which the standard sidereal clock is attached.

The Collimator Piers. The alcoves of the transit circle room were constructed solely to receive these piers. They are solid structures, extending through the floor of the transit room, and are each surmounted by solid blocks of limestone, on which rest the iron plates carrying the Y's of the collimators.

Beside the pier for the chronograph, there are two piers (one on each side of the transit pier), supporting a broad, smooth stone, and insulating it from the floor. This stone is adapted to a mercury carriage for reflection observations.

THE INSTRUMENTS.

The Equatorial. The equatorial refracting telescope, by Alvan Clark & Sons, has an aperture of 12¼ inches, and a focal length of 17 feet. The tube is of steel, and is mounted on an iron stand which supports the axles in the usual manner of the Clark telescopes. The declination circle is 20 inches in diameter, is graduated to 15′ of arc, and is read by verniers to 15″. The hour circle is 15 inches in diameter, is graduated to single minutes of time, and is read by the verniers to single seconds. Attached to the polar axle is a sector of brass, the rim of which carries a flexible strip, also of brass. This strip coils round a drum, whose supporting pivots are firmly attached to the iron stand of the instrument. By means of the brass strip the action of the driving clock is communicated to the polar axle by simply clamping the sector on the axle. A horizontal endless screw, set in motion by the clock-work, fits into oblique notches in the rim of a wheel attached to the drum, and thus sets the drum in motion. The action of the weight, on the train of wheels in the driving clock, is regulated by a very simple form of conical pendulum.

The finder of the telescope has an aperture of 3 inches, and a focal length of 50 inches. The amplifying power generally employed with the finder is about 20 diameters. The clamp handle, for the declination axle, and the slow motion screw, are both in easy reach of the observer at the eye-end of the instrument. There is a tail-piece screwing into the tube, which is specially adapted to the use of the negative eye-pieces. These, in the order of magnifying power, are—

A	of magnifying power,	50
B	“ “ “	150
C	“ “ “	275
D	“ “ “	500
E	“ “ “	800
F	“ “ “	1200

There is also provided for negative eye-pieces a total reflecting prism, for the convenient observation of stars near the zenith; also a single reflecting prism, and a variety of shades for observing the sun, are furnished.

The positive or micrometer eye-pieces, are—

A	of magnifying power,	50
B	“ “ “	175
C	“ “ “	275
D	“ “ “	450
E	(periscopic, by Gundlach),	600
F	of magnifying power,	800

The instrument is provided with a large position-circle filar micrometer, of the pattern described by Prof. Newcomb in the Washington observations for 1873, and repeated with more detail in the volume for 1874. The entire micrometer frame is movable by a comparatively coarse screw, parallel to the fine screw of the micrometer itself. There are three fixed threads, and one thread movable by the micrometer screw. One of the fixed threads is parallel to the micrometer screw, and serves principally to mark the middle of the field of view in this direction. It is called the longitudinal thread. Of the two fixed threads at right angles to this, it is found convenient in observation to designate the one nearest the micrometer screw head by the letter *A*, while the more distant thread is designated by the letter *B*. The place of *A* on the scale is 106.100 revolutions, while that of *B* is 86.440 revolutions, so that the interval between them is $19^r.660 = 253''.81$, the value of one revolution of the micrometer screw being $12''.91$. The number of complete revolutions of the screw is automatically indicated on the scale by an index point; and the fraction of a revolution is read on the screw head, which is 2.8 inches in diameter.

There are two methods of illuminating the threads, both effected by a swinging lamp. The first, called field illumination, gives dark wires on a bright field. It is preferred when the objects to be measured are both bright. The second, which gives bright wires on a dark field, is always used for faint and very close objects. When white light is used, all the threads are alike illuminated for any position of the lamp, but where red light is used (as generally occurs), only the threads in one direction are illuminated. To illuminate the others, the thimble carrying the lamp must be revolved 90°. In the tube through which light proceeds from the lamp to the field, is a revolving disc, by which the light is regulated.

In observing comets and asteroids, it is usual to obtain a convenient number of transits over the three short threads (thus saving time); then revolve the micrometer 90° and obtain a convenient number of bisections for differences of declination; then again revolve the micrometer 90°, and obtain a series of transits similar to the first. This method is always used when red light is employed. But when both objects are sufficiently bright to allow the use of white light, the transits and bisections can be taken without revolving the micrometer, and without any break in the series.

The value of a revolution of the micrometer screw has been obtained from several hundred transits of stars at various declinations over the fixed threads. This determination has been repeated at different seasons of the year. The value $12''.91$ is the mean of all the determinations. In measuring the angular distance of double stars, of satellites from center of primary, etc., only that part of the screw is used contiguous to one of the fixed threads, while in the differential observations for comets and planets, all the parts of the screw are called into requisition — the range of the scale being 150 revolutions. Whether the value of a revolution of the screw is uniform throughout its whole length has not yet been determined by placing it under the microscope of a measuring engine; but numerous comparisons of measures made at different parts of the screw leave no doubt of this uniformity. The position circle is 6.8 inches in diameter, is graduated to degrees, and is read by two opposite verniers to 5'. It is furnished with clamp and slow motion screw.

The cost of the instrument, in the shop, was $6,000 in gold. It was mounted in December, 1875, by Messrs. George and Alvan Clark, Jr., of the firm of Alvan Clark & Sons. Since its mounting, it has been employed in several fields of work, so far as opportunity was afforded. Chief among them have been observations of double stars, observations of planets and satellites, occultations of stars and planets, and observations of comets.

After using the instrument for nine years, we note two defects in its mounting which we desire to see removed. One is absence of facility for setting the instrument and reading the circles from the eye end. The other want is a better method of illuminating the threads for faint objects. The excellent optical qualities of the objective have been proven in numerous instances.

The Meridian Circle. The transit circle, by Troughton & Simms, London, was sent over in the "Parthia," late in the fall of 1876, and was mounted on the transit pier in June, 1877, Mr. George Clark of the firm of Alvan Clark & Sons, and Mr. W. F. Gardner, instrument maker at the U. S. Naval Observatory, both co-operating in the work. The objective is 6 inches aperture, and the focal length 77 inches. The horizontal axis and central cube are of brass, cast in a single piece, the edges of the cube being 13 inches. Into this axis are firmly fitted the steel pivots, 3.5 inches in diameter, and 3.5 inches in length. The distance between the centers of the bearing surfaces of Y's is three feet and nine inches. They are of gun-metal, with bearing surfaces 2½ inches long, and ¾ of an inch wide. The Y's are attached firmly to a polished metallic base, and have almost no adjustments for azimuth or level. This fact made the work of mounting the instrument one of extreme care and precision. When once correctly mounted, it tends to the greater stability of the instrument. The base of the Y's is firmly attached by heavy screws to a polished projection of the iron columns which stand on the cap-stones of the pier. These projections are 5 inches in height, and 3 inches in width, thus leaving a large part of the upper surface of the columns for another and important use. The iron columns, supporting both the Y's and the heavy axle of rotation, are 5 feet and 5 inches in height from their base on the stones to the base of the Y's. Their bases are widened out by heavy mouldings, and are 32 × 24 inches; at the top the columns are 13 x 11 inches, and have a level polished surface, to receive the heavy plates carrying the circles to which the microscopes are attached. At the corners of their bases are anchors (called lewises), which are let into the rock and made fast with plaster of Paris. The counterpoises for relieving the pivots act on levers passing through the iron columns near their bases. These levers press upward vertical steel cylinders 1½ inches in diameter, carrying at the upper end pairs of friction rollers 8 inches in diameter, and with a bearing surface of ¾ inch. The weights and levers are out of sight, being hidden by the columns and platform. The circles are discs of brass, with strengthening ribs on the inside, at every 30°. They are 24 inches in diameter, are both graduated alike on a band of silver to 5′, and are each read by four microscopes to single seconds of arc. They are so mounted on the axle that they each read zero when the telescope is directed to the south point of the horizon.

The tubes of the microscopes are 21 inches in length, and are supported at two points 8 inches apart, on plates of brass, carrying the adjusting screws. These plates are clamped on circular bands of brass, 6 inches broad, which are supported on heavy iron plates, resting on the upper surface of the iron columns. A finding microscope is attached to the eastern microscope circle, for accurate setting of the circles. It is so convenient, that, in practice, the finding circles on the sides are seldom used. The microscopes on the west side are marked *A, B, C, D;* those on the east side, *F, G, H, I.*

The cube has two opposite circular openings, closed by revolving discs. These openings are used in connection with the collimators. The clamp is attached to the eastern pier, and has to be removed when the instrument is reversed. The reversing carriage runs from its usual place on a pair of iron rails to a turn-table fitted in the floor. It is then turned into position, and rolls on another set of rails to its proper place under the axis. By a few turns of the large screw of the reverser, the instrument is gently lifted out of its bearings, and the carriage is rolled back upon the turn-table, which is again revolved 180°. The carriage is then rolled back between the piers, and the instrument lowered by the screw into the Y's.

Finding circles are placed near the eye-end of the telescope, and on opposite sides of the steel tube. They are 7.6 inches in diameter, and are graduated to 20′, and read by opposite verniers to 30″. Each circle is provided with a spirit level, clamp, and slow motion screw. When the transits of stars succeed each other very rapidly, provision can be made in advance for three separate settings, by means of the two finding circles and the finder of the microscope circles.

The right ascension micrometer carries 15 parallel threads, all fixed relatively to each other. They are arranged in groups of 5 each. The entire system of threads is moved together by the micrometer screw. The groups in the order of the upper culmination are distinguished by the letters, *A, B* and *C*, and the number of the thread by numeral subscripts. It is rarely necessary to use more than 9 of these threads, and the equatorial intervals of these, taken symmetrically from the middle thread, are given in the subjoined table. These intervals have been determined by a large number of transits of both equatorial and northern stars.

When the threads have to be replaced, of course the intervals have to be redetermined. The intervals of the following table have been in use since the instrument was mounted.

$A_4 = +24^{s}.583$ $A_5 = +20.069$	$B_1 = +10^{s}.007$ $B_2 = +\ \ 5.996$ $B_3 = \ \ \ \ 0.000$ $B_4 = -\ \ 6.003$ $B_5 = -10.017$	$C_1 = -20^{s}.073$ $C_2 = -24.673$

The value of one revolution of the right ascension micrometer screw is $1^s.642$. It was determined by comparisons with the equatorial thread intervals, as under the screw, the successive threads were made to coincide with a vertical collimator thread, noting the reading of the screw for each thread-coincidence, and repeating the process many times, always taking care to move the screw in the same direction. The value given results from all the comparisons with all the threads. The head of the screw registers both the entire revolutions and the fractional parts. As the screws of both the right ascension and zenith distance micrometers of this instrument move the whole system of threads, the service of the right ascension micrometer becomes more important than that of micrometers of a different construction. It is used in determining, not only the collimation constant $= c$ and the level constant $= b$, but also to set the micrometer, so that the middle thread, B_3 (to which all the others are referred), may have its collimation equal to zero.

The value of one revolution of the zenith distance micrometer is $49''.442$. It was determined from successive divisions of the circle, and coincidences of the middle horizontal micrometer thread, with a horizontal collimator thread, reading the microscopes for each circle division, and the micrometer head for each corresponding coincidence, repeating the process many times, and always moving the screw in the same direction, and taking the mean of all the results. The two side-threads of the zenith distance micrometer are placed about $2\frac{1}{2}'$ from the middle thread, and the head of the screw registers both the entire revolutions and the fractional parts.

Illumination. At night the threads are illuminated by the light of a large lamp, placed at the distance of $3\frac{1}{2}$ feet from the end of the pivot. The light is first concentrated on the lens in the pivot by a lens placed near the lamp. On passing into the cube it falls on a reflecting ring, so placed as to direct it to the reticule of threads. There is also provision for illuminating the threads directly, without brightening the field. There are also two series of prisms so disposed as to produce a strong illumination on those points of the circle within the field of the microscopes. Two eye-pieces, magnifying respectively 100 and 170, are employed in observing transits and bisections. A fine diagonal eye-piece also accompanies the instrument, but there is rarely any occasion to use it.

INSTRUMENTAL CONSTANTS.

The Error of Level is obtained by pointing the instrument towards the nadir (270°), upon an insulated basin of mercury, suspended on a frame by elastic cords.

The apparatus is below the floor, and is usually covered by an iron lid. To counteract the effect of vibrations, it is found best to have the convex surface of the basin nearly spherical, and to load the mercury with tin foil. A platform, readily moved, is provided for this observation, to which the observer ascends by a flight of steps to the eye-end of the instrument. He first replaces the ordinary eye-piece by a Bohnenberger or collimating eye-piece, then sets the telescope accurately to 270°. The light of a side lamp, after passing through a lens, is reflected down the tube, and when the focus of the eye-piece and the reflector are properly adjusted, both the threads of the reticule are seen directly, and their images are seen by reflection from the mercury. If no error of level exists, each thread will coincide with its own reflected image, the collimation being zero. Whatever deviation from this may be, is carefully ascertained by the micrometer. While this method of taking the level has some advantages compared with that by the hanging or striding level, still it has some disadvantages, of which, in practice, the most serious are the effects of wind in producing slight tremor, or the jarring of the surface produced by passing trains or carriages, or even the tramp of a heavy animal. These disturbing effects are greatest when the ground is hard frozen, or when the air is very dry and cold. Also, when a number of threads are visible in the field, there is a slight liability to superpose a thread, not on its own image, but on the image of a contiguous thread. Again, by this method the level must always be found in association with the collimation. To obtain the nadir point, in observing altitudes or zenith distances, the same process is employed as for the level, only using the horizontal threads and the zenith distance micrometer.

The Error of Collimation. For the independent determination of this error, the transit circle is furnished with two opposing collimating telescopes, mounted on their piers, in the alcoves, at equal distances from the transit circle axis, north and south, and in the plane of the meridian. The objectives of the collimators are $4\frac{1}{3}$ inches in diameter, and have focal lengths of $4\frac{1}{4}$ feet. The distances between the centers of the bearing surfaces of the Y's are 3 feet, 10 inches. In the focus of each collimator are fixed two close vertical threads, about $5''.3$ apart, and one horizontal thread. The frame carrying these threads is moveable by the micrometer screw, and the motion given to the threads is indicated on the head of the screw. In determining the collimation constant, care is first taken to adjust properly the vertical and parallel threads in each collimator. For this purpose the transit circle is pointed approximately to the nadir. The discs covering the openings in the cube are turned aside, and the reflecting ring is drawn back. An observer, then, by means of the screw, brings one of the parallel threads of the south collimator to the central line between the parallel threads of the north collimator, as they are seen in the field. Several independent readings are taken for this thread in this position. Then the other parallel thread of the south collimator is brought into the same position, and a like number of readings made. The mean of the two sets of readings gives the reading of the screw-head, at which there is perfect coincidence of both sets of parallel threads. The screw is turned in one constant direction, to this reading, and the coincidence tested by the eye. The collimators are then ready for use. The telescope of the transit circle is then directed to the vertical threads of the north collimator, and by the right ascension micrometer screw, thread B_3 is brought to the central line between the parallels, as seen in the field, and several independent readings are made. The instrument is then revolved 180°, and pointed on the threads of the south collimator, and a like number of independent readings made. The mean of these sets of readings gives the micrometer reading for collimation $= o$. To this reading the micrometer is then set, so that when the level is taken, soon after, the relative position of B_3, and its image at once indicates the magnitude and sign of the level. With a Bohnenberger collimating eye-piece, if the image of B_3 (when set to collimation $= o$), appears to the east of the thread itself, then the west pivot of the transit circle is highest, and *vice versa.*

The Azimuth Constant. The usual method of deducing the azimuth error is by means of an approximate clock correction, and an observation on one or more of the four stars α, δ, λ *Ursæ Minoris*, or 51 *Cephei.* Sometimes the error is deduced from a pair of stars differing nearly 90° in declination, and one of which is circumpolar. When great accuracy is important, the observations are thrown into the form of equations, of which the azimuth constant is one of the unknowns, and the solution is effected by the method of least squares.

Error of the Mean of Threads. When the mean of the times of transit is taken over threads symmetrically placed, a small correction is required to reduce to the middle thread. Except for stars very near the pole, the correction is usually combined with the diurnal aberration. With the present system of threads, both corrections combined only amount to $-0^s.03$ for stars south of the zenith.

The Chronograph. The chronograph was constructed by Alvan Clark & Sons. Its barrel is 19 inches in circumference, and 15 inches in length. Upon a sheet of paper clamped round the cylinder, the clock registers every second except the zero second. The action of the weight, upon the train of wheel work, is regulated by a conical pendulum, like that of the equatorial driving clock. Lateral motion is given to the pen carriage by the action of a long horizontal screw, so that the pen traces on the paper a continuous spiral. The successive lengths of this spiral, as traced in one revolution, appear as parallel lines when the sheet is spread out on a plane. By means of a finely graduated scale, the chronograph record is read to hundredths of a second of time. The chronograph is placed on its pier in a closet communicating with the computing room, so that the ink may not freeze in cold weather.

SIDEREAL CLOCK AND CHRONOMETER.

Sidereal Clock. The standard clock of the Observatory is by Charles Frodsham, 84 Strand, London, and bears the number 1369. It came over with the transit circle, and was mounted at the same time. The stone shaft to which it is attached is 6½ feet in height, and a cross section is 15 × 7 inches. To this shaft the clock case is first attached by a single point of support, and afterwards fixed in a vertical position by two staying screws. The clock has a break-circuit attachment, similar to that of a chronometer. An extra wheel on the main shaft carries 59 teeth, and lifts a light spring, which breaks the circuit every second, except the zero second. The clock case is inclosed in a double external case, made very strong and firmly attached to the floor. This serves to protect the clock from jars, from dust and moisture, and to a great extent from extremes of temperature.

Sidereal Break Circuit Chronometer. The chronometer, Negus 1590, may be used on the chronograph like the clock. When thus used, it is placed on a short circuit of its own, and the current is supplied by a small Leclanche cell. A spark condenser is also employed to obviate the corroding of the contact points.

Portable Equatorial. The Observatory owns a very nice equatorial telescope, of 4 inches aperture, by A. Clark & Sons. The tripod is a heavy walnut frame, and is capable of several adjustments. Beside the equatorial mounting, the cradle of the telescope may be so adjusted as to give the instrument an altitude and azimuth movement. As it is furnished with a comet eye-piece, it may be used as a comet seeker. Besides a terrestrial eye-piece, a solar eye-piece and shades, and a ring-micrometer eye-piece, it has a series of powers, 40, 65, 84, 160, 333. It is furnished with a case for ready and safe transportation, and is specially useful for expeditions to observe transits or eclipses. It was loaned to the U. S. Venus-Transit Commission to New Zealand, in 1882; and was used by Prof. H. S. Pritchett, in observing the transit at Auckland.

Altazimuth. A very diminutive traveler's theodolite, by Casella, London. The circles are graduated to degrees, and read by verniers to single minutes. The telescope is only 6 inches in length, and ¾ inch aperture. Still it has yielded some surprising results, and was of excellent use in the mounting of the larger instruments.

MINOR INSTRUMENTS.

Barometer and Thermometers. The stationary mercurial barometer, with attached thermometer, is by James Green of New York. It bears the number 2167. It is mounted on a board prepared by the maker, having supports and adjusting and clamp screws. It is permanently fixed in its vertical position against a facing of the north window of the eastern room. The altitude of the mercury cistern above sea level is 750.00 feet.

The External Thermometer, No. 4091, by James Green, is fixed the year round on the outside frame of the north window of transit room, and is sheltered from sun and rain by the slat-blinds. As there is frequent occasion to read these instruments, not only for the daily meteorological record, but for the determination of refraction, it is convenient to have them so easily accessible from both instruments.

Telegraph Instruments. A complete set of telegraph instruments, with apparatus for sending time signals, is placed in the library room, though the instruments are not owned by the Observatory. They may be used on two different lines of telegraph.

THE LIBRARY.

In addition to the private collection of the Director, the Observatory is gradually acquiring by purchase and donation many works on theoretical and practical astronomy and associated sciences, which are needful to one in the line of actual work. All the American observatories, which have issued publications, have placed this Observatory on their lists, and their publications are promptly received when issued. This fact is the more gratefully acknowledged, as hitherto we have had no publication of our own to offer in return. In this connection, special mention must be made of the United States Naval Observatory, the Observatory of Harvard College, the Cincinnati Observatory, the Washburn Observatory, the Observatory of Hamilton College, the Dudley Observatory, the Dearborne Observatory, the Allegheny Observatory, and the Lick Observatory. Of foreign observatories, special mention must be made of the Royal Observatory, Greenwich; Lord Crawford's Observatory, Dun Echt; the Edinburgh Observatory; the Dunsink Observatory; Observatorio Nacional, Mexico; the Imperial Observatory, Rio Janeiro; Observatory of Santiago, Chili; and the Observatorio Nacional, Argentino. We are also under special obligations to the Smithsonian Institution, Washington, not only for some of its own publications, but for its valuable agency in receiving and forwarding books from foreign countries, and thus promoting international exchange; also to the office of the *American Ephemeris and Nautical Almanac*, under the charge of Prof. Newcomb; the offices of the United States Coast Survey, and of the United States Signal Service, and to the executive officers of the American Academy of Sciences, and of the British and American Venus-Transit Commissions. The authors of numerous memoirs and treatises on scientific subjects, especially in the United States, have kindly remembered this Observatory. Foremost among these contributors, is Doctor C. H. F. Peters, of the Litchfield Observatory of Hamilton College. The first series (No. 1–20) of his valuable *Celestial Charts*, was received more than two years ago.

INCOME OF THE OBSERVATORY.

Of the $50,000 given by Miss BERENICE MORRISON to the Observatory, there remains unexpended the sum of $27,000, which is bearing interest. The interest accruing from this endowment is, at present, the sole resource for meeting current expenses and supporting an Astronomer. To say nothing of taxes, the claims for insurance against both fire and storm, the expenses for repairs on grounds, building and instruments, the cost of printing, fuel, lights, stationery, postage, express, telegraphy, etc., leave but a residuary income — one which might be inadequate to sustain a family, but for the comfortable residence on the grounds, which has been built under a special arrangement with the Director, and the cost of which was defrayed to a great extent, by a few liberal citizens of Glasgow. For the benefit of any who may feel disposed to criticise the instrumental equipment, as out of all reasonable proportion to the endowment, it is necessary to make this brief explanation. This result was brought about by unfortunate misunderstanding. It was never designed to be so. The original plan of the Observatory contemplated an Astronomer in charge, an Assistant, and provision for running expenses. Though the work of this Observatory has been much crippled, and still is crippled, through lack of means, yet the privation is borne by those who planned it, in patient expectation of a better day.

LEGAL CONTROL.

The legal control of the Observatory is vested, by the designation of Miss MORRISON, in a Board of Trustees, consisting of the same persons, who for the time being may constitute the corporate body, know as the "Trustees of Pritchett School Institute." But they are Trustees of the MORRISON OBSERVATORY, not in their character of Trustees of Pritchett School Institute, but simply from the fact of the preoccupation of that trust. It is their duty to hold the property and funds of the Observatory, oversee its interests, invest securely its funds, and appoint its Director, allowing him to appoint such assistants as his resources may warrant. The present Board of Trustees consists of the following named persons, — Luke F. Hayden, John M. Hickerson, George B. Harrison, James O. Swinney, James W. Southworth, and Carr W. Pritchett. The conditions and limitations of the trust are fully set forth in the "Declaration of Trust," signed in duplicate by Miss MORRISON and the Trustees, on May 18, A.D. 1881.

LONGITUDE OF MERIDIAN PIER.

When our work commenced, in 1876, the facilities available for the accurate determination of the longitude were meagre. Of course approximations were first in order. The longitude of a point in the city of St. Louis (now occupied by the pier of the transit instrument of Washington University), had been determined from the United States Naval Observatory, in April, 1870, by Professors Harkness and Eimbeck. From data furnished by the Surveyor of St. Louis County, I was enabled to connect this point with certain contiguous points of the United States surveys of the public lands. Also by numerous details kindly and carefully furnished from the office of Register of Lands at Jefferson City, I was enabled to connect these contiguous points with the site of this Observatory. This first approximation to the longitude came out $6^h\ 11^m\ 17^s.52$ west of Greenwich — a result surprisingly near the true difference, as will be seen hereafter.

In the mean time, during 1876–77, a number of occultations of stars by the moon was observed, and while I was able in no single instance to obtain corresponding observations at any other fixed observatory, and thus to form equations by which the errors of the elements could be eliminated, yet applying the empirical corrections of Prof. Newcomb to the moon's places, the mean of eleven (11) occultations gave as a second approximation $6^h\ 11^m\ 16^s.80$ west of Greenwich.

In the spring of 1879, through an arrangement kindly made by Prof. J. R. Eastman, of the United States Naval Observatory, and by the accommodation of the officers of the W. U. Telegraph Company, signals were transmitted in accordance with a fixed programme from the M. T. clock of the United States Naval Observatory, over a continuous circuit, on the evenings of March 24, 25, 26, 27, 28, and were received in the telegraph office, Glasgow, Mo., and compared with sidereal chronometer, Negus 1590. This chronometer had been carefully compared on leaving the Observatory with the standard sidereal clock, Frodsham 1369. It was then firmly stayed, and carried by hand to the depot of the St. Louis, Kansas City & Northern R. R., nearly two miles distant. On returning to the Observatory, the chronometer was again compared with the clock, on each evening. The errors of the clock were deduced each day from well determined stars observed at meridian transit, the instrumental corrections having been carefully ascertained. The mean result for the five evenings, after applying ultimate corrections, and ignoring the wave and armature interval, was $1^h\ 3^m\ 5^s.74$ west of the old dome of the United States Naval Observatory, or $6^h\ 11^m\ 17^s.83$ west of Greenwich.

While the preceding result was quite satisfactory, it was yet determined to use the first opportunity for a complete exchange of signals. On the completion of the Chicago & Alton R. R. to Kansas City, permission was obtained from Supt. Wilson, to connect the Observatory with one of the main wires of that line. Under the prompt management of Supt. W. K. Morley, the connection was made in May, 1880, and the Observatory was placed permanently on wire No. 15 from Bloomington to Kansas City. At my request, the details of the exchange were arranged by Prof. J. R. Eastman of the United States Naval Observatory, and the programme was carried into effect in the months of June and July following. A full account of the work constitutes *Appendix No. 5, Washington Observations of 1877.* As one prominent design of this present publication is to give in detail the authority for the geographical co-ordinates of the Observatory, it will be necessary to transcribe a considerable part of that Appendix.

Programme for Exchange: "The arrangement for the exchange of signals on each night was, briefly, to allow the Washington clock to break the closed circuit from Washington to Glasgow (including of course the necessary divisions of the main line by means of repeaters), each second for three minutes, recording each break on the chronograph at Washington and on the chronograph at Glasgow. Then the Glasgow clock was allowed to break the circuit in the same way for three minutes. The hour and the first and last minute of the recorded signals of the Washington clock were telegraphed to Glasgow, and similar data in relation to the Glasgow clock were received from Glasgow; and this completed the exchange of signals. Similar apparatus was used at both stations for sending and receiving signals."

Observations at the United States Naval Observatory. "The observations for the determination of the clock corrections at the Naval Observatory were made by Prof. J. R. Eastman, U.S.N., with the transit circle. A description of this instrument, and an explanation of the methods of reduction, may be found in any of the annual volumes of the Observatory since 1870. For clock corrections in this determination of longitude, only stars of the *American Ephemeris* were observed, and the corrections given in the table below were applied to the positions given in the *Ephemeris*. The corrections employed in the computations at the Morrison Observatory are from the same list of systematic corrections."

CORRECTIONS TO AMERICAN EPHEMERIS.

	s.		s.		s.
Polaris	—0.36	β Urs. Min.		ζ Ophiuchi	0.00
48 Cephei		β Bootis	+0.03	η Herculis	—0.01
12 Can. Venat.	+0.03	μ^1 Bootis	—0.05	ϰ Ophiuchi	0.08
ϑ Virginis	—0.05	α Cor. Bor.	+0.01	*d* Herculis	+0.20
ζ Virginis	0.01	α Serpentis	0.03	ε Urs. Min.	
η Bootis	—0.04	ε Serpentis	—0.01	α^1 Herculis	+0.02
ϑ Bootis	+0.08	ε Cor. Bor.	—0.05	α Ophiuchi	0.04
5 Urs. Min.		δ Ophiuchi	+0.02	μ Herculis	+0.04
ε^2 Bootis	+0.01	τ Herculis	+0.18	δ Urs. Min.	—0.06
α^2 Libræ	0.00	η Draconis	—0.01		

"In the case of *48 Cephei, 5 Ursæ Minoris,* β *Ursæ Minoris,* and ε *Ursæ Minoris,* the uncorrected ephemerides were used, as no well authenticated corrections were known. The azimuth constant was obtained by the method of least squares from all the observations on each night. The level constant was obtained from observations with the hanging level. The collimation constant was obtained from observations on two opposing collimating telescopes in the usual way, and (as the constant varies with the temperature), two values are given on each night at the hours noted in the table below, and the values for other epochs were interpolated on the assumption that the rate of change of temperature was uniform."

CONSTANTS USED IN THE REDUCTION OF OBSERVATIONS.

Date.	Hour.	c	b	a
1880.		s.	s.	s.
June 16	14.7	—0.006	—0.200	—1.165
	17.0	+0.004		
" 17	12.8	—0.052	—0.080	—1.309
	16.3	0.012		
" 19	14.4	0.033	—0.207	—1.301
	16.9	0.013		
" 21	14.4	0.061	—0.212	—1.183
	16.7	0.055		
July 2	15.0	0.056	—0.220	—1.246
	18.2	—0.040		

OBSERVATIONS AND DEDUCED CLOCK CORRECTIONS AT THE NAVAL OBSERVATORY.

Date.	STAR.	Observer.	No. of Threads	Mean Thread.	*Aa.*	*Bb.*	*Cc.*	Instrumental Correction.	Correct Transit	Adopted Right Ascension.	Observed Clock Correction	*v*
1880.				*h. m. s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*
June 16	α^2 Libræ	E	9	14 44 44.41	−0.984	−0.120	−0.006	− 1.11	43.30	18.10	−25.20	0.03
"	β Urs. Min.	E	8	51 31.14	+2.571	0.613	0.023	+ 1.94	33.08	7.83		
"	β Bootis	E	9	14 57 54.16	+0.052	0.264	0.007	− 0.22	53.94	28.74	.20	0.02
"	μ^1 Bootis	E	9	15 20 26.23	−0.028	0.253	0.004	0.28	25.95	0.68	.27	0.05
"	ε Serpentis	E	9	15 45 19.70	0.655	0.166	−0.002	0.82	18.88	53.66	.22	0.00
"	δ Ophiuchi	E	9	16 8 33.31	−0.785	0.148	0.000	0.93	32.38	7.21	.17	0.05
"	τ Herculis	E	8	16 36.69	+0.227	0.288	+0.001	0.06	36.63	11.37	.26	0.04
"	ζ Ophiuchi	E	9	31 3.34	−0.896	0.133	0.002	1.03	2.31	37.05	.26	0.04
"	η Herculis	E	9	39 15.73	+0.007	0.258	0.003	0.25	15.48	50.26	.22	0.00
"	ϰ Ophiuchi	E	9	52 28.89	−0.580	0.177	0.003	0.75	28.14	2.94	.20	0.01
"	*d* Herculis	E	9	57 39.46	−0.125	0.240	0.005	− 0.36	39.10	13.94	−25.16	0.05
"	ε Urs. Min.	E	6	16 58 44.25	+5.916	−1.076	+0.030	+ 4.87	49.12	23.94		
June 17	12 Can. Ven.	E	9	12 50 53.54	+0.003	−0.103	−0.067	− 0.17	53.37	27.56	−25.81	0.05
"	ϑ Virginis	E	9	18 4 13.90	−0.908	−0.058	−0.049	1.02	12.88	47.16	.72	0.04
"	Polaris s.p.	E	8	15 46.21	44.644	+2.098	+2.022	40.52	5.69	39.94		
"	ζ Virginis	E	9	29 4.46	0.823	−0.062	−0.044	0.93	3.53	37.78	.75	0.01
"	η Bootis	E	9	13 49 27.59	−0.471	−0.080	0.043	− 0.59	27.00	1.30	.70	0.06
"	ϑ Bootis	E	9	14 21 35.29	+0.500	0.128	0.056	+ 0.32	35.61	9.81	.80	0.04
"	β Bootis	E	9	14 57 54.60	+0.059	0.106	0.036	− 0.08	54.52	28.73	.79	0.03
"	μ^1 Bootis	E	9	15 20 26.66	−0.031	0.101	0.030	0.16	26.50	0.67	.83	0.07
"	ε Serpentis	E	9	45 20.22	0.736	0.066	0.018	0.82	19.40	53.66	.74	0.02
"	ε Coronæ	E	9	15 53 6.72	0.298	.088	0.019	0.40	6.32	40.58	.74	0.02
"	δ Ophiuchi	E	9	16 8 33.90	−0.882	−0.059	−0.014	− 0.96	32.94	7.21	25.73	0.03
June 19	ϑ Bootis	E	9	14 21 36.26	+0.497	−0.330	−0.054	+ 0.11	36.37	9.77	26.60	0.01
"	5 Urs. Min.	E	9	28 15.76	+3.315	0.691	0.134	+ 2.49	18.25	51.25		
"	ε^2 Bootis	E	9	40 15.11	−0.287	0.229	0.035	− 0.55	14.56	47.97	.59	0.03
"	α^2 Libræ	E	9	44 45.97	−1.099	0.125	0.032	− 1.26	44.71	18.09	.62	0.01
"	β Urs. Min.	E	9	51 32.34	+2.871	0.634	0.110	+ 2.13	34.47	7.66		
"	β Bootis	E	9	14 57 55.60	+0.058	−0.273	−0.037	− 0.25	55.35	28.71	.64	0.01
"	48 Ceph. s.p.	E	9	15 5 41.81	−5.307	+0.415	+0.123	4.77	37.04	10.06		
"	μ^1 Bootis	E	9	20 27.67	0.031	−0.262	−0.033	0.33	27.34	0.65	.69	0.04
"	ε Cor. Bor.	E	9	15 53 7.77	0.296	0.228	0.024	0.55	7.22	40.58	.64	0.03
"	δ Ophiuchi	E	9	16 8 34.96	0.877	0.153	0.019	1.05	33.91	7.21	.70	0.02
"	ζ Ophiuchi	E	9	31 4.88	−1.000	0.137	0.016	1.15	3.73	37.06	.67	0.02
"	η Herculis	E	9	39 17.27	+0.008	0.267	0.019	0.28	16.99	50.26	.73	0.03
"	ϰ Ophiuchi	E	9	52 30.42	−0.648	0.183	0.013	0.84	29.58	2.95	.63	0.07
"	*d* Herculis	E	9	57 41.08	−0.140	0.248	0.014	− 0.40	40.68	13.95	26.73	0.02
"	ε Urs. Min.	E	5	16 58 45.07	+6.606	−1.114	−0.089	+ 5.40	50.47	23.77		
June 21	ϑ Bootis	E	8	14 21 37.44	+0.452	−0.338	−0.100	+ 0.01	37.45	9.73	27.72	0.06
"	ε^2 Bootis	E	9	40 16.12	−0.261	0.234	0.068	− 0.56	15.56	47.95	.61	0.06
"	α^2 Libræ	E	9	44 46.96	−1.000	0.128	0.062	− 1.19	45.77	18.08	.69	0.02
"	β Urs. Min.	E	9	51 33.48	+2.611	0.650	0.227	+ 1.73	35.21	7.54		
"	β Bootis	E	9	14 57 56.71	+0.053	−0.280	−0.078	− 0.30	56.41	28.69	.72	0.05
"	48 Ceph. s.p.	E	8	15 5 42.08	−4.826	+0.425	+0.268	4.13	37.95	10.24		
"	μ^1 Bootis	E	9	20 28.69	0.028	−0.268	−0.075	0.37	28.32	0.63	.69	0.01
"	α Cor. Bor.	E	9	30 7.93	0.272	0.233	0.065	0.57	7.36	39.74	.62	0.06
"	α Serpentis	E	9	38 53.19	0.633	0.181	0.058	0.87	52.62	24.99	.63	0.05
"	ε Serpentis	E	9	15 45 22.19	0.665	0.176	0.057	0.90	21.29	53.66	.63	0.05
"	δ Ophiuchi	E	9	16 8 35.87	−0.797	0.157	0.057	1.01	34.86	7.21	−27.65	0.04
"	τ Herculis	E	8	16 39.26	+0.231	0.305	0.082	− 0.16	39.10	11.34	.76	0.07
"	η Draconis	E	9	22 52.63	+0.975	0.413	0.118	+ 0.44	53.07	25.49		
"	ζ Ophiuchi	E	9	31 5.84	−0.910	0.141	0.057	− 1.11	4.73	37.07	.66	0.04
"	η Herculis	E	9	16 39 18.37	+0.007	−0.273	−0.071	− 0.34	18.03	50.25	−27.78	0.28

OBSERVATIONS AND DEDUCED CLOCK CORRECTIONS AT THE NAVAL OBSERVATORY—CONTINUED.

Date.	STAR.	Observer.	No. of Threads.	Mean Thread.	Aa.	Bb.	Cc.	Instrumental Correction.	Correct Transit	Adopted Right Ascension.	Observed Clock Correction	v
1880.				h. m. s.	s.	s.	s.	s.	s.	s.	s.	s.
July 2	β Bootis	E	9	14 57 59.38	+ 0.056	−0.290	−0.074	− 0.31	59.07	28.54	−30.53	0.04
"	α Cor. Bor.	E	9	15 30 10.70	− 0.287	0.242	0.061	0.59	10.11	39.65	.46	0.04
"	α Serpentis	E	7	15 38 56.39	0.666	0.188	0.053	0.91	55.48	24.94	.54	0.03
"	δ Ophiuchi	E	9	16 8 38.73	0.840	0.163	0.050	1.05	37.68	7.21	.47	0.05
"	ϰ Ophiuchi	E	9	52 34.42	0.621	0.194	0.048	0.86	33.56	2.98	.58	0.05
"	d Herculis	E	9	57 44.98	− 0.135	0.264	0.055	− 0.45	44.53	13.93	.60	0.06
"	ε Urs. Min.	E	6	16 58 48.46	+ 6.328	1.184	0.340	+ 4.80	53.26	22.74		
"	α^1 Herculis	E	9	17 9 45.46	− 0.532	0.207	0.046	− 0.78	44.68	14.20	.48	0.06
"	α Ophiuchi	E	9	29 56.90	0.566	0.202	0.045	0.81	56.09	25.57	.52	0.03
"	μ Herculis	E	9	17 42 20.41	− 0.272	0.244	0.048	− 0.56	19.85	49.27	−30.58	0.03
"	δ Urs. Min.	E	7	18 11 26.47	+15.582	−2.502	−0.676	+12.40	38.87	8.35		

"The following adopted clock corrections and rates were obtained by the method of least squares from all the 'observed clock corrections.'"

"The corrections for personal equation given in the following table, were derived from observations with the personal equation apparatus described in the *Washington Observations for 1875.* These observations were made each night during the time occupied in observing stars for clock corrections, and doubtless represent very nearly the absolute error of the observer. These determinations indicate that the observations were made *too late* by about 0^s.18."

ADOPTED CLOCK CORRECTIONS AT THE NAVAL OBSERVATORY.

Day.	Sid. Hour.	Clock Correction.	Correction for Personal Equation.	Hourly Rate.
1880.	h.	s. s.	s.	s.
June 16	15.80	−25.217 ± 0.008	+0.210	−0.0065
" 17	15.80	25.760 ± 0.009	0.173	+0.0008
" 19	16.20	26.675 ± 0.007	0.164	−0.0366
" 21	16.20	27.690 ± 0.011	0.165	−0.0158
July 2	18.20	−30.563 ± 0.011	+0.190	−0.0203

THE WORK AT THE MORRISON OBSERVATORY.

[The observations and computations at the MORRISON OBSERVATORY were all made by Mr. Henry S. Pritchett, A.M., and were communicated by letter to Prof. J. R. Eastman, of the United States Naval Observatory. This letter is embodied in Prof. Eastman's report. In describing the work, its language will be followed, as far as practicable. — C. W. P.]

The Instruments. A description of these, as given in the letter of Mr. H. S. Pritchett, is omitted here, as they are fully described in a previous part of this publication.

Personal Equation. "The relative personal equation of Professor Eastman and myself has been determined at various times during the last three years, both with the machine invented by him, and by independent determinations of clock corrections, with the meridian circle of the Naval Observatory. For the present series of observations he kindly loaned one of his machines, and determinations of personal equation were made by me on each evening but one, both before and after the exchange of signals. On June 19, only one series of observations was made. The principle of the machine, and the method of observation, are fully described in the Washington volume for 1875. The results of the different nights are shown in the following table. Observations were made over five wires, so that each set furnished five determinations of personal equations."

DETERMINATION OF PERSONAL EQUATION.

Date.	Sid. Time.	No. Sets.	Personal Eq.
1880.	*h.*		*s.*
June 16	13.9	6	—0.218
" 16	16.9	6	—0.210
" 17	13.9	7	—0.177
" 17	16.1	6	—0.168
" 19	16.9	9	—0.164
" 21	14.2	6	—0.155
" 21	16.2	6	—0.153
July 2	15.5	3	—0.163
" 2	18.2	7	—0.167

"These values are quite in accord with determinations of personal equation made during 1878–79, when I was one of the regular observers on the meridian circle of the Naval Observatory."

DETERMINATION OF INSTRUMENTAL CONSTANTS.

"*The Collimation Constant* was determined from a pair of opposing collimators. In the present observations two determinations were made on each evening — one just before and one just after the observations for time — the mean of the two being used in reducing the observations."

"*The Level Constant* was determined by reflection from Mercury, using a collimating eye-piece, which necessitates the removal of the ordinary eye-piece whenever an observation for level is made. Two observations for level were made each evening, and the mean of the two was used as the correction for the evening."

"*The Azimuth Constant* was determined by least squares from all the stars."

"In the table following, *a*, *b* and *c* denote respectively, the azimuth, level, and collimation constants."

INSTRUMENTAL CONSTANTS.

Date.	a	b	c
1880.	s.	s.	s.
June 16	+0.340	+0.377	0.000
" 17	.465	.363	−0.005
" 19	.385	.381	0.000
" 21	.392	.341	+0.003
July 2	+0.333	+0.371	0.000

"On June 16, the azimuth constant, clock correction, and rate, were determined directly from the observations by the method of least squares. On the other dates a series of equations of condition was formed, involving as unknown quantities azimuth constant and clock error. The azimuth, thus determined, was used for obtaining the individual clock corrections from the different stars. The circumpolar stars were then thrown out, and another solution by least squares was made for rate and clock correction at the epoch of exchange."

"On June 16, a power of 100 was used; on the other dates a power of 170. The time stars of the *American Ephemeris* were used, with *Newcomb's Right Ascensions*. In the original programme it was intended to use no stars brighter than the third magnitude, but on account of clouds this programme had to be modified on several nights. On several occasions, stars as bright as the second magnitude were used, but the clock corrections from these stars show no systematic differences from the others. Hence they have been retained."

"In the table following, the times, given under the title 'Observed Time,' have been reduced to the middle thread and corrected for the daily aberration. In the column '*v*' are the residuals, obtained after introducing the clock correction and rate into the equations of condition."

OBSERVATIONS AND DEDUCED CLOCK CORRECTIONS AT MORRISON OBSERVATORY.

Date.	STAR.	No. of Threads.	Observed Time.	*Aa.*	*Bb.*	*Cc.*	Instrumental Correction.	Corrected Time.	Adopted Right Ascens'n	Observed Clock Correct'n.	*v*
1880.			h. m. s.	s.	s.	s.	s.	s.	s.	s.	s.
June 16	12 Can. Ven.	9	12 51 22.78	+0.002	+0.485	0.000	+0.49	23.27	27.57	−55.70	+0.01
"	ϑ Virginis	9	13 4 42.36	.237	.271	.000	.51	42.87	47.18	.69	.00
"	ζ Virginis	9	29 32.94	+ .215	.292	.000	.51	33.45	37.78	.67	— .02
"	η Urs. Maj.	9	44 46.89	— .097	.575	.000	.48	47.37	51.68	.69	.00
"	η Bootis	9	13 49 56.51	+ .124	.374	.000	.50	57.01	1.31	.70	+ .01
"	β Libræ	9	15 11 31.89	.256	.254	.000	.51	32.40	36 67	.73	.03
"	α Cor. Bor.	9	30 35.01	.080	.414	.000	.49	35.50	39.77	.73	+ .03
"	α Serpentis	9	39 20.14	.183	.320	.000	.50	20.64	24.99	.65	— .05
"	ε Serpentis	9	45 48.86	.192	.312	.000	.50	49.36	53.66	.70	.00
"	ε Cor. Bor.	9	15 53 35.77	.080	.415	.000	.50	36.27	50.59	.68	— .03
"	δ Ophiuchi	9	16 9 2.43	+0.230	+0.278	0.000	+0.51	2.94	7.21	−55.73	+0.02

OBSERVATIONS AND DEDUCED CLOCK CORRECTIONS AT MORRISON OBSERVATORY — CONTINUED.

Date.	STAR.	No. of Threads.	Observed Time.	*Aa.*	*Bb.*	*Cc.*	Instrumental Correction.	Corrected Time.	Adopted Right Ascens'n	Observed Clock Correction	*v*
1880.			*h. m. s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*	*s.*
June 17	12 Can. Ven.	9	12 51 22.77	+0.003	+0.471	—0.007	+0.47	23.24	27.55	—55.69	0.00
“	ϑ Virginis	9	13 4 42.28	.310	.261	.004	.57	42.85	47.17	.68	—0.01
“	ζ Virginis	9	29 32 93	+ .280	.281	.004	.56	33.49	37.78	.71	+0.02
“	η Urs. Min.	9	43 46.88	— .127	.554	.007	.42	47.30	51.66	.64	—0.05
“	η Bootis	9	13 49 56.44	+ .162	.360	.005	.52	56.96	1.30	.66	—0.03
“	β Bootis	9	14 58 24.05	— .016	.480	.006	.46	24.51	28.73	.78	+0.08
“	β Libræ	9	15 11 31.81	+ .334	.245	.005	.57	32.38	36.67	.71	.01
“	μ^1 Bootis	9	20 55.93	.015	.459	.006	.47	56.40	0.68	.72	+ .02
“	α Cor. Bor.	9	30 34.97	.105	.398	.006	.50	35.47	39.67	.71	.00
“	α Serpentis	9	39 20.14	.240	.308	.005	.54	20.68	24.99	.69	— .02
“	ε Serpentis	9	45 48.81	.252	.301	.005	.55	49.36	53.66	.70	0.01
“	ε Cor. Bor.	9	15 53 35.78	.100	.399	.006	.49	36.27	40.59	.68	— .03
“	δ Ophiuchi	7	16 8 2.38	+ .300	.268	.005	+0.56	2.94	7.21	.73	+ .02
“	ε Urs. Min.	5	16 59 19.76	—2.232	+1.966	—0.037	—0.30	19.46	23.77	—55.69	
June 19	α Bootis	9	14 11 9.64	+0.136	+0.382	0.000	0.52	10.16	14.35	—55.81	—0.02
“	5 Urs. Min.	7	28 46.81	—0.973	1.278	.000	.31	47.12	51.25		
“	α^2 Libræ	9	14 45 13.42	+ .326	0.248	.000	.55	13.97	18.09	.88	+0.05
“	α Cor. Bor.	9	15 30 35.09	.091	.418	.000	.51	35.60	39.75	.85	+0.02
“	α Serpentis	9	39 20.27	.208	.323	.000	.53	20.80	24.99	.81	—0.02
“	ε Serpentis	9	45 48.94	+0.219	0.315	.000	.53	49.47	53.66	.81	—0.02
“	ζ Urs. Min.	5	49 21.96	—1.178	+1.445	.000	.26	22.22	26.46		
“	ε Cor. Bor.	9	15 53 35.84	+0.090	0.419	.000	.51	36.35	40.59	.76	—0.08
“	δ Ophiuchi	9	16 9 2.52	.261	.281	.000	.54	3.06	7.21	.85	+0.01
“	ζ Ophiuchi	9	31 32.35	.298	.251	.000	.55	32.90	37.06	.84	.00
“	η Herculis	7	39 45.66	+0.001	0.491	.000	.49	46.15	50.27	—55.88	+0.04
“	ε Urs. Min.	9	16 59 19.49	—1.941	+2.063	.000	+0.12	19.61	23.76		
June 21	ϑ Virginis	9	13 4 42.55	+0.271	+0.246	+0.003	+0.52	43.07	47.13	—55.94	—0.01
“	ζ Virginis	9	29 33.18	.248	.264	.003	.52	33.70	37.74	.96	+0.01
“	η Bootis	9	13 49 56.74	+ .143	.338	.003	.48	57.22	1.26	.96	+0.01
“	α Draconis	9	14 2 7.08	— .401	.726	.007	.33	7.41	11.48		
“	ϑ Bootis	5	14 22 5.28	— .145	.544	.005	.40	5.68	9.73	.95	.00
“	α Cor. Bor.	7	15 30 35.24	+ .093	.374	.003	.47	35.71	39.74	.97	+ .02
“	α Serpentis	9	39 20.43	.212	.290	.003	.51	20.94	24.98	.96	+ .01
“	ε Serpentis	9	15 45 49.09	.223	.282	.003	.51	49.60	53.66	.94	— .01
“	δ Ophiuchi	9	16 9 2.64	+ .266	.251	.003	.52	3.16	7.21	.95	.01
“	τ Herculis	7	17 6.82	— .073	.492	.004	.42	7.24	11.33	.91	— .05
“	ζ Ophiuchi	9	31 32.53	+ .303	.225	.003	.53	33.06	37.07	.99	+ .03
“	η Herculis	9	39 45.77	.001	.440	.003	.44	46.21	50.26	.95	— .01
“	κ Ophiuchi	9	52 58.42	+0.197	0.300	.003	+ .50	58.92	2.95	—55.97	+0.01
“	ε Urs. Min.	7	16 59 19.69	—1.976	+1.847	+0.022	—0.11	19.57	23.63		
July 2	ϑ Bootis	9	14 21 8.74	—0.124	+0.592	0.000	+0.47	9.21	9.47	+ 0.26	+0.02
“	5 Urs. Min.	9	27 49.59	—0.840	1.245	.000	.40	49.99	50.25		
“	ε Bootis	9	39 47.06	+ .076	0.410	.000	.49	47.55	47.83	.28	—0.01
“	α^2 Libræ	9	44 17.26	+ .283	0.222	.000	.50	17.76	18.01	.25	+0.02
“	β Urs. Min.	9	51 6.16	— .728	1.142	.000	.41	6.57	6.82		
“	β Bootis	9	14 57 27.76	— .014	0.490	.000	.48	28.24	28.54	.30	—0.03
“	β Libræ	9	15 10 35.85	+ .251	.250	.000	.50	36.35	36.62	.27	.00
“	μ^1 Bootis	9	19 59.72	.012	.469	.000	.48	0.20	0.51	.31	— .04
“	ε Serpentis	5	15 44 52.89	.189	.307	.000	.50	53.39	53.62	.23	+ .04
“	μ Herculis	9	17 41 48.51	+ .075	.411	.000	.49	49.00	49.26	.26	+ .01
“	γ Draconis	9	17 53 51.72	— .113	.582	.000	.47	52.19	52.52	.33	— .06
“	η Serpentis	9	18 15 9.32	+ .224	.275	.000	.50	9.82	10.06	.24	+ .03
“	1 Aquilæ	9	18 28 44.04	+0.248	+0.253	.000	+0.50	44.54	44.79	+ 0.25	+0.02

"The solution by least squares, in the manner indicated above, affords the following values of the clock correction and rates on the different dates. In explanation of the break in the continuity of the clock correction, for July 2, it must be stated, that the clock stopped June 23. It was immediately taken down and cleaned, and resumed almost exactly the same rate on which it had been running before."

ADOPTED CLOCK CORRECTIONS AND RATES.

Date.	Glasgow Sid. Time.	Clock Correction.	Prob. Error.	Hourly Rate.
1880.	*h.*	*s.*	*s.*	*s.*
June 16	15.0	—55.6976	±0.0091	—0.00879
" 17	14.6	55.6998	±0.0066	0.00654
" 19	15.0	55.8345	±0.0105	0.00652
" 21	15.0	—55.9536	±0.0042	0.00164
July 2	16.8	+ 0.2705	±0.0106	—0.00203

"On each night, clock-beats were sent for three minutes each way. The signals sent from Washington to Glasgow, give the following comparison of clocks. The last column gives the number of separate comparisons read off from the sheet."

WASHINGTON TO GLASGOW.

Date.	Frodsham 1369.	Kessels 1324.	No. of Comparisons.
1880.	*h. m. s.*	*h. m. s.*	
June 16	15 2 54.8535	16 5 30.0	60
" 17	14 35 26.3208	15 38 2.0	76
" 19	15 2 53.5235	16 5 30.0	94
" 21	15 2 52.6637	16 5 30.0	103
July 2	16 46 3.4999	17 49 40.0	70

"On the western division of the circuit much of the success of the exchange is due to Mr. W. K. Morley, Superintendent of Telegraph on the Chicago & Alton R. R. He not only afforded every facility in his power, but was personally present on several nights of the exchange. We are also indebted to Mr. H. K. Waters, and Mr. William Wickes, for their services as operators."

(Signed) HENRY S. PRITCHETT,
Astronomer, Morrison Observatory.

WASHINGTON RECORD OF SIGNALS.

"The record of twenty clock signals from Glasgow were read from the chronograph sheets for comparison on each night, and the mean of each set is given below. The Glasgow record of observations and signals was compared with the odd-seconds record of the clock on the Glasgow chronograph, and accordingly only the odd-seconds record of the Glasgow clock on the Washington chronograph was used in the comparison of signals."

MEAN OF CLOCK SIGNALS FROM GLASGOW TO WASHINGTON.

Date.	No. of Signals.	Glasgow Clock.	Washington Clock.
1880.		*h. m. s.*	*h. m. s.*
June 16	20	14 45 28.000	15 44 3.600
" 17	20	14 42 6.368	15 44 42.508
" 19	20	15 12 40.000	16 15 16.864
" 21	20	15 10 44.000	16 13 21.804
July 2	20	17 10 6.895	18 13 43.852

TELEGRAPH LINES, REPEATERS AND BATTERIES.

"On June 16, 19, 21, and July 2, repeaters were employed at Pittsburgh, Indianapolis, and St. Louis. On June 17, the circuit through Philadelphia was used, and repeaters were employed at Harrisburg, Pittsburgh, Indianapolis, and St. Louis."

"At Washington, and all the repeating stations, the batteries employed were the gravity batteries in general use by the Western Union Telegraph Company. The average number of cells employed each night at the several stations was 100, except on June 19, when 225 cells were used at the Washington office, 140 at Pittsburgh, 150 at Indianapolis, and 125 at St. Louis."

The length of telegraph wire used is as follows: —

Washington to Pittsburgh, via Philadelphia and Harrisburg,	490	miles.
Washington to Pittsburgh, direct, . . .	343	"
Pittsburgh to Indianapolis, ...	374	"
Indianapolis to St. Louis, ...	239	"
St. Louis to Glasgow, via Jefferson City and Kansas City,	380	"
Total length of wire, June 19, . . .	1483	"
Total length of wire, on other nights, . .	1336	"

TABLE SHOWING THE COMPARISON OF SIGNALS, THE APPLIED CLOCK CORRECTIONS, AND THE DEDUCED LONGITUDE ON EACH NIGHT.

Date.	Signals—Glasgow to Washington.		Signals—Washington to Glasgow.		Difference of Longitude, from Signals G. to W.	Difference of Longitude, from Signals W. to G.	Mean Difference of Longitude.	Wave and Armature Time.
	Glasgow Clock.	Washington Clock	Glasgow Clock.	Washington Clock				
1880.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*s.*
June 16	14 45 28.000	15 48 3.600	15 2 54.854	16 5 30.000				
"	—55.482	—25.207	—55.484	—25.009				
"	14 44 32.518	15 47 38.593	15 1 59.370	16 5 4.991	1 3 6.075	1 3 5.621	1 3 5.848	0.227
June 17	14 42 6.368	15 44 42.508	14 35 26.321	15 38 2.000				
"	—55.529	—25.587	—55.528	—25.587				
"	14 41 10.839	15 44 16.921	14 34 30.793	15 37 36.413	1 3 6.082	1 3 5.620	1 3 5.851	0.231
June 19	15 12 40.000	16 15 16.864	15 2 53.524	16 5 30.000				
"	—55.671	—26.513	—55.670	—26.507				
"	15 11 44.329	16 14 50.351	15 1 57.854	16 5 3.493	1 3 6.022	1 3 5.639	1 3 5.830	0.191
June 21	15 10 44.000	16 13 21.804	15 2 52.664	16 5 30.000				
"	—55.800	—27.525	—55.800	—27.523				
"	15 9 48.200	16 12 54.279	15 1 56.864	16 5 2.477	1 3 6.079	1 3 5.613	1 3 5.846	0.233
July 2	17 10 6.895	18 13 43.852	16 46 3.500	17 49 40.000				
"	+0.434	—30.374	+0.435	—30.365				
"	17 10 7.329	18 13 13.478	16 46 3.935	17 49 9.635	1 3 6.149	1 3 5.700	1 3 5.924	0.224
						Mean	1 3 5.860	0.221

"The transit circle of this Observatory is $0^s.066$ west of the central, or old dome, from which all longitudes are reckoned. Applying this correction to the mean value of the determinations above, we have the transit circle of the MORRISON OBSERVATORY, at Glasgow, Missouri, $1^h\ 3^m\ 5^s.926$ west of the central dome of the United States Naval Observatory."

"My thanks are due Mr. M. Marean, of the Western Union Telegraph Office of Washington, for his skillful management of the telegraph lines in the exchange of signals and messages."

Very respectfully,
(Signed) J. R. EASTMAN,
Professor of Mathematics, U. S. N.

WASHINGTON, D.C., *Dec. 15, 1880.*

Rear-Admiral JOHN ROGERS, U.S.N.,
Superintendent United States Naval Observatory.

LATITUDE OF MERIDIAN PIER.

Soon after the meridian circle was mounted, in the autumn of 1877, a series of observations on circumpolar stars was made by Mr. Henry S. Pritchett, relative to a preliminary determination of the Latitude of the Meridian Pier. In this series the stars were bisected a number of times when near the meridian, and on each side of it; and the micrometer reading given for each star is the mean of all the reductions to the meridian. Error of runs in the microscopes was avoided by setting always on the nearest circle division, both for the nadir and the star.

The observations are tabulated below. Under C' are entered the circle readings for the stars, after corrections from the microscopes, F, G, H, I. Under (M) are entered the technical micrometer zeros, or each (M) is the number of seconds (C_0) expressed in revolutions of micrometer from 270°, given by the microscopes, $+ M_0 =$ the nadir micrometer reading, or $(M) = C_0 + M_0$. In this series C_0 is generally negative. N' is the *apparent* nadir distance of the star, h' the *apparent* altitude, h the *true* altitude, and ϕ the latitude. The refraction was always computed by Bessel's tables, derived from the formula, $R = \alpha\, \beta^{A}\, \gamma^{\lambda} \tan z$ — (*Vid. Tab. Regiomont.*, or *Ast. Untersuch.*, Band I.). For the residuals, the usual notation of least squares is employed.

1877.	STAR.	No. Bis.	C'	M'	(M)	$M'-(M)$ in Rev.	$M'-(M)$ in Arc.	N'	h'
			° ′ ″	r.	r.	r.	′ ″	° ′ ″	° ′ ″
Oct. 11	α Urs. Min. s.p.	7	142 4 57.47	7.668	10.0914	2.4234[a]	1 59.81[a]	232 2 57.66	37 57 2.34
" 11	δ Urs. Min.	15	137 20 0.16	9.339	10.0875	0.7485[a]	0 37.01[a]	227 19 23.15	42 40 36.85
" 11	51 Cephei s.p.	11	143 29 54.82	8.655	10.0875	1.4325	1 10.82	233 28 44.00	36 31 16.00
" 13	α Urs. Min. s.p.	9	142 4 58.38	7.682	10.0768	2.3948	1 58.56	232 2 59.82	37 57 0.18
" 13	δ Urs. Min.	11	137 19 56.85	9.434	10.0760	0.6420	0 31.74	227 19 25.11	42 40 34.89
" 13	α Urs. Min.	7	139 24 55.21	6.804	10.0760	3.2720	2 41.77	229 22 13.44	40 37 46.56
" 22	α Urs. Min. s.p.	7	142 4 58.15	7.605	10.1435	2.5385	2 5.50	232 2 52.65	37 57 7.35
" 22	δ Urs. Min.	9	137 19 57.22	9.412	10.1316	0.7196	0 35.57	227 19 21.65	42 40 38.35
" 22	51 Cephei s.p.	9	143 29 55.46	8.672	10.1316	1.4596	1 12.16	233 28 43.30	36 31 16.70
" 22	α Urs. Min.	9	139 24 59.11	6.802	10.1198	3.3178	2 44.03	229 22 15.08	40 37 44.92
" 23	α Urs. Min. s.p.	7	142 4 58.43	7.603	10.1328	2.5298	2 5.07	232 2 53.36	37 57 6.64
" 23	51 Cephei s.p.	7	143 29 56.68	8.672	10.1280	1.4560	1 11.97	233 28 44.71	36 31 15.29
" 26	δ Urs. Min.	11	137 20 0.14	9.403	10.1482	0.7452	0 36.85	227 19 23.29	42 40 36.71
" 26	51 Cephei s.p.	7	143 29 59.08	8.637	10.1482	1.5112	1 14.71	233 28 44.37	36 31 15.63
" 26	λ Urs. Min.	5	139 40 1.00	9.099	10.1482	1.0492	0 51.87	229 39 9.13	40 20 50.87
" 26	α Urs. Min.	9	139 24 58.75	6.867	10.1430	3.2760	2 41.97	229 22 16.78	40 37 43.22
" 29	α Urs. Min. s.p.	6	142 4 59.61	7.511	10.1354	2.6244	2 9.75	232 2 49.86	37 57 10.14
" 29	51 Cephei s.p.	9	143 29 57.50	8.620	10.1382	1.5182	1 15.06	233 28 42.44	36 31 17.56
" 31	α Urs. Min. s.p.	9	142 4 54.96	7.575	10.1340	2.5590	2 6.52	232 2 48.44	37 57 11.56
Nov. 3	α Urs. Min. s.p.	9	142 4 57.19	7.517	10.1285	2.6115	2 9.11	232 2 48.08	37 57 11.92
" 5	α Urs. Min.	9	139 25 3.21	6.809	10.1603	3.3513	2 45.69	229 22 17.52	40 37 42.48
" 10	α Urs. Min. s.p.	9	142 4 55.12	7.463	10.1349	2.6719	2 12.10	232 2 43.02	37 57 16.98
" 10	α Urs. Min.	9	139 24 57.27	6.918	10.1309	3.2129	2 38.84	229 22 18.43	40 37 41.57
" 12	α Urs. Min. s.p.	11	142 4 54.30	7.510	10.1292	2.6192	2 9.49	232 2 44.81	37 57 15.19
" 12	α Urs. Min.	7	139 25 0.49	6.910	10.1280	3.2180	2 39.10	229 22 21.39	40 37 38.61
" 15	α Urs. Min. s.p.	9	142 4 56.62	7.472	10.1479	2.6759	2 12.29	232 2 44.33	37 57 15.67
" 15	α Urs. Min.	9	139 24 59.15	6.994	10.1477	3.1537	2 35.92	229 22 23.23	40 37 36.77
" 16	α Urs. Min. s.p.	5	142 4 57.75	7.440	10.1473	2.7073	2 13.85	232 2 43.90	37 57 16.10
" 16	α Urs. Min.	9	139 24 57.76	7.029	10.1473	3.1183	2 34.17	229 22 23.59	40 37 36.41
" 17	α Urs. Min. s.p.	9	142 4 55.32	7.476	10.1506	2.6746	2 12.23	232 2 43.09	37 57 16.91
" 17	α Urs. Min.	9	139 24 52.81	7.119	10.1480	3.0290	2 29.75	229 22 23.06	40 37 36.94
" 22	α Urs. Min.	7	139 24 59.11	7.037	10.1612	3.1242[a]	2 34.46[a]	229 22 24.65	40 37 35.35
" 23	α Urs. Min.	9	139 24 56.71	7.090	10.1413	3.0513[a]	2 30.87[a]	229 22 25.84	40 37 34.16

1877.	Barometer.	Att. Ther.	Ext. Ther.	Refraction	h	90-δ	ϕ	v	vv
				″	° ′ ″	° ′ ″	° ′ ″		
Oct. 11	29.500	59.0 F	58.0 F	72.17	37 55 50.17	1 20 27.10	39 16 17.27	—0.55	0.302
" 11	29.362	60.0	59.5	60.72	42 39 36.13	3 23 19.10	17.03	—0.31	0.096
" 11	29.362	60.0	59.5	75.55	36 30 0.45	2 46 16.60	17.05	—0.33	0.109
" 13	29.170	70.0	69.0	69.82	37 55 50.36	1 20 26.20	16.56	+0.16	0.026
" 13	29.140	70.8	70.0	58.92	37 39 35.97	3 23 19.20	16.77	—0.05	0.002
" 13	29.160	66.5	66.1	63.83	40 36 42.73	1 20 25.98	16.75	—0.03	0.001
" 22	29.382	53.0	52.9	72.64	37 55 54.71	1 20 22.44	17.15	—0.43	0.185
" 22	29.312	57.0	55.5	61.03	42 39 37.32	3 23 20.20	17.12	—0.40	0.160
" 22	29.312	57.0	55.5	75.89	36 30 6.81	2 46 16.10	16.91	—0.19	0.036
" 22	29.320	52.5	52.5	65.97	40 36 38.95	1 20 22.58	16.37	+0.33	0.109
" 23	29.314	56.0	56.0	72.02	37 55 54.62	1 20 22.45	17.07	—0.37	0.137
" 23	29.200	60.0	59.0	75.07	36 30 0.24	2 46 16.05	16.29	+0.43	0.185
" 26	29.062	61.0	59.8	59.96	42 39 36.77	3 13 20.70	16.07	+0.65	0.422
" 26	29.062	61.0	59.8	74.64	36 30 0.99	2 46 15.85	16.84	—0.12	0.014
" 26	29.064	58.5	57.5	65.05	40 19 45.82	1 3 30.00	15.82	+0.90	0.810
" 26	29.020	55.0	55.0	64.93	40 36 38.29	1 20 21,08	17.21	—0.49	0.240
" 29	29.492	52.0	52.0	72.97	37 55 57.17	1 20 19.98	17.18	—0.46	0.212
" 29	29.468	53.0	53.0	76.74	36 30 0.82	2 46 15.55	16.37	+0.35	0.122
" 31	29.360	48.5	47.5	73.43	37 55 58.13	1 20 19.24	17.37	—0.65	0.422
Nov. 3	29.392	49.0	48.0	73.39	37 55 58.53	1 20 18.28	16.81	—0.09	0.008
" 5	29.690	32.0	32.0	69.70	40 36 32.78	1 20 17.29	15.49	+1.23	1.512
" 10	29.694	37.0	36.6	75.91	37 56 1.08	1 20 15.69	16.77	—0.05	0.002
" 10	29.544	37.0	37.0	68.63	40 36 32.94	1 20 15.48	17.46	—0.74	0.548
" 12	29.404	45.0	44.0	74.02	37 56 1.17	1 20 14.95	16.12	+0.60	0.360
" 12	29.250	47.0	46.5	66.61	40 36 32.00	1 20 14.80	17.20	—0.48	0.230
" 15	29.370	52.0	50.7	72.92	37 56 2.75	1 20 13.95	16.70	+0.02	0.000
" 15	29.350	49.0	49.3	66.47	40 36 30.30	1 20 13.78	16.52	+0.20	0.040
" 16	29.318	52.0	51.0	72.76	37 56 3.34	1 20 13.66	17.00	—0.28	0.078
" 16	29.292	52.6	52.0	65.98	40 36 30.43	1 20 13.51	16.92	—0.20	0.040
" 17	29.414	47.0	46.0	73.75	37 56 3.16	1 20 13.35	16.51	+0.21	0.044
" 17	29.460	48.5	47.8	66.91	40 36 30.03	1 20 13.21	16.82	—0.10	0.010
" 22	29.356	42.5	42.0	67.48	40 36 27.87	1 20 11.58	16.29	+0.43	0.185
" 23	29.154	40.5	40.5	67.23	40 36 26.93	1 20 11.18	15.75	—0.97	0.941
					Mean value of	ϕ	30 16 16.72	$[vv]$	7.588

Deduced probable error of any single observation ± 0″.33. Probable error of the arithmetic mean ± 0″.057. Therefore, from these observations, $\phi = 39° — 16′ — 16″.72 \pm 0″.057$.

According to the theory of probabilities, if $\triangle$ be the general symbol for the residual errors, h the measure of precision, according to Gauss, r the probable error of any single observation, e the base of Naperian logarithms, and n a general multiplier, the integral,

$$\frac{2}{\sqrt{\pi}} \int_0^{nhr} e^{-t^2} dt$$

(where $t = h\triangle$) gives the probability of an error, which is less than n times the probable error; and although in so small a number of observations we can not expect the errors to be rigorously distributed according to this law, yet an inspection of the subjoined table will show that this is approximately done.

	$\frac{1}{2} r$	r	$\frac{3}{2} r$	$2 r$	$\frac{5}{2} r$	$3 r$
Number of errors which *should* occur, less than =	9	16	23	27	30	32
Number actually occurring, . . . =	8	15	24	29	30	32

The error which stands exactly in the *middle of all errors,* arranged in the order of their magnitude, and which ought to be equal to the probable error, according to theory, is 0.35, while the *next two* errors are each 0.33 — showing that aside from *constant errors,* the observations were well made.

Again, taking from the foregoing observations the corrected altitudes of Polaris, as observed successively above and below the Pole, and applying the small corrections, $\triangle \delta$, due to the dates, we have independently of the star's absolute declination, the following values.

1877.	*U. C.*	*L. C.*	$\triangle \delta$	ϕ
	° ′ ″	° ′ ″	″	° ′ ″
Oct. 13		37 55 50.36	+0.10	39 16 16.64
" 13	40 36 42.73			
" 22		54.71	+0.09	16.92
" 22	38.95			
" 22	38.95		−0.15	16.64
" 23		54.62		
" 26	38.29		−0.86	16.87
" 29		57.17		
Nov. 10		56 1.08	+0.10	17.11
" 10	32.94			
" 10	32.94		−0.26	16.79
" 12		1.17		
" 12		1.17	+0.09	16.67
" 12	32.00			
" 15		2.75	+0.08	16.61
" 15	30.30			
" 15	30.30		−0.08	16.74
" 16		3.34		
" 16		3.34	+0.09	16.47
" 16	30.43			
" 16	30.43		−0.08	16.72
" 17		3.16		
" 17		3.16	+0.08	16.68
" 17	30.03			
		Mean value of	ϕ	39 16 16.797

The Latitude of the Meridian Pier, resulting from these observations, is 39° 16′ 16″.76 ± 0″.05; and this value has for several years appeared in the *American Ephemeris.* It was found more than a year ago, that a large constant error had entered into this result. It occured in fixing the nadir point. In obtaining the nadir from the mercury collimator, the finder of the circle was set to the nearest division, which is 270, and the microscopes *F*, *G*, *H*, *I*, were then read. The middle thread of the declination micrometer was then brought into coincidence with its own image (as was supposed), as seen by reflection in the mercury collimator, and the mean of a number of micrometer readings taken. But, unfortunately, the middle micrometer thread was brought into coincidence, not with its own image, but was superposed on the image of the northern side thread, as seen in the field with the collimating eye-piece. As only two of the fixed and parallel threads are visible in the field without sliding the eye-piece, this constant error, in fixing the zero of the circle, was perpetuated for some months without detection. With a single thread, no such error could have occurred. The history of this error is carefully recited, since it affords an instructive instance of the intrusion of constant error into the most carefully conducted observations.

In September, 1883, three series of readings were made to determine the angular difference between the coincidence of the middle thread with its own image, and with the image of the northern side thread, as seen in the field. The following are the observations and results.

I. Coincidence of Mid. Th.				II. Coincidence of Mid. Th.				III. Coincidence of Mid. Th.			
Own Image.		Northern Image.		Own Image.		Northern Image.		Own Image.		Northern Image.	
r.		r.		r.		r.		r.		r.	
17.332	.362	14.256	.305	17.305	.361	14.260	.302	17.312	.362	14.261	.300
.320	.372	.260	.310	.312	.365	.262	.310	.312	.366	.252	.315
.322	.365	.265	.302	.310	.362	.252	.302	.316	.369	.256	.300
.315	.361	.255	.302	.315	.360	.262	.315	.316	.361	.257	.302
.322	.361	.256	.309	.310	.365	.263	.310	.312	.366	.259	.300
$17^r.343$		$14^r.282$		$17^r.337$		$14^r.284$		$17^r.339$		$14^r.280$	
$D = 3^r.061$				$D = 3^r.053$				$D = 3^r.059$			

General Mean, $3^r.0576 = 151''.1738 = 2'\ 31''.17$. Applying this correction, the proper value of $\phi = 39° - 13' - 45''.59$.

During July, August and September, 1883, a protracted series of observations was made on the zenith distances of stars situated all along the meridian, from 30° of south declination to the North Pole. A number of these stars was observed in the lower culmination, and some by reflection from mercury; hence almost every section of the circle divisions was called into requisition during the series.

It was determined, moreover, to dispense with the micrometer in bisecting the star; and having very carefully ascertained the circle and micrometer reading, when the middle thread was in coincidence with its own image, over the mercury, the micrometer was set exactly to that reading, and remained unchanged until a new determination was made. The star was bisected but once, and then when on the transit thread marking the meridian and collimation $= o$. The ultimate bisections were effected by the tangent screw connected with the clamp. The stars were all taken from the enlarged list of the *American Ephemeris.* For the asterisk stars the apparent declination was rigidly computed. The barometer and thermometers were all read very frequently, and the refraction was always computed by Bessel's formula, $R = \alpha\ \beta^A\ \gamma^\lambda\ \tan z$ — (*Tabulæ Regiomontanæ*, p. xlii., and *Astronomische Untersuchungen*, Band I., pp. 198–202). The columns of the table will generally explain themselves; but it is proper to remark, that the column marked "Micsps.," is the mean of readings of microscopes *F*, *G*, *H*, *I*, corrected for error of runs. C' denotes the preceding circle division increased by the reading of the microscopes, z denotes the apparent zenith distance, R the refraction, ζ the true zenith distance, and ϕ the latitude. For the residuals the usual notation is employed. From July 9 to July 20, the observations were made by Prof. Henry S. Pritchett; all later observations were made by C. W. Pritchett, Jr. From observations made at numerous intervals of the circle July 24, 27 and 31, the mean correction for error of runs, was determined to be $+0''.953$ for each circle division of $5'$, as measured by the microscopic micrometers, or $+0''.19$ for each minute ($1'$) measured. The latitude is deduced from the true zenith distance, by the formula $\phi = \zeta + \delta$ for the upper culmination, and $\phi = 180 - (\zeta + \delta)$ for the lower culmination. As our meridian circle is mounted to read zero, when the telescope is directed to the south point of the horizon, it will be seen that in the formula above ζ is positive for stars south of the zenith, and negative (in *U. C.*) for stars between the zenith and pole. The letter R attached to some stars, denotes that they were observed by reflection from mercury.

1883, July 9 — *Observer*, Henry S. Pritchett. Corrected Nadir Point $= N_0$. From (1 to 7) 270° 0′ 6″.61. From (8 to 11) 270° 0′ 6″.54. Nadir Micrometer Reading $= M_0$. From (1 to 7) $M_0 = 17^r.644$. From (8 to 11) $M_0 = 17^r.658$. Barometer $= B$ (1–7) 29.392 in. B (8–11) $= 29.392$ in. Attached Thermometer $= T$ (1–11) $= 77$ *Fah.* External Thermometer $= T'$ (1–11) $= 78$ *Fah.*

Stars.	No.	E. Runs	Micsps.	C'	z	R	ζ	δ	ϕ	v	vv
		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
α^2 Can. Ven.	1	0.65	3 26.52	89 43 26.52	0 16 40.09	0.26	0 16 40.35	38 57 3.20	39 13 43.55	+2.04	4.162
Polaris s.p.	2	0.81	4 15.78	142 4 15.78	52 4 9.17	69.18	52 5 18.35	88 40 57.50	44.15	+1.44	2.074
ζ Virginis	3	0.40	2 7.12	50 47 7.12	39 12 59.49	44.06	39 13 43.55	0 0 1.20	44.75	+0.84	0.706
η Urs. Maj.	4	0.03	0 8.28	100 40 8.28	10 40 1.67	10.19	10 40 11.86	49 53 57.70	45.84	—0.25	0.062
η Bootis	5	0.14	0 44.96	69 45 44.96	20 14 21.65	19.95	20 14 41.60	18 59 3.53	45.13	+0.46	0.212
α Draconis	6	0.42	2 12.37	115 42 12.37	25 42 5.76	26.04	25 42 31.80	64 56 16.63	44.83	+0.76	0.578
α Bootis	7	0.80	4 12.67	70 34 12.67	19 25 53.94	19.09	19 26 13.03	19 47 30.67	43.70	+1.89	3.572
α Scorpii	8	0.57	3 1.09	24 38 1.09	65 22 5.45	117.62	65 24 3.07	—26 10 18.80	44.27	+1.32	1.742
η Herculis	9	0.07	0 16.97	89 55 16.97	0 4 49.57	0.08	0 4 49.65	39 8 55.01	44.66	+0.93	0.865
κ Oph.	10	0.09	0 28.59	60 20 28.59	29 39 37.95	30.88	29 40 8.83	9 33 35.74	44.57	+1.02	1.040
d Herculis	11	0.17	0 53.99	84 30 53.99	5 29 12.55	5.21	5 29 17.76	33 44 29.62	47.38	—1.79	3.204

1883, JULY 11 — *Observer*, HENRY S. PRITCHETT. N_0 (12–14) = 270° 0′ 24″.58. N_0 (15–26) = 270° 0′ 7″.64. M_0 (12–14) = $17^r.280$. M_0 (15–26) = $17^r.614$. B (12–14) = 29.100. B (15–26) = 29.068. T_a (12–14) = 81. T_a (15–25) = 77. T_a (26) = 76.5. T_e (12–14) = 82.5. T_e (15–19) = 76.5. T_e (20–25) = 75.2. T_e (26) = 74.5.

STARS.	No.	E. Runs	Mlesps.	C	z	R	ζ	δ	ϕ	v	vv
		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
Polaris s.p.	12	0.85	4 35.52	142 4 35.32	52 4 10.74	67.90	52 5 18.64	88 40 57.50	39 13 43.86	+1.73	2.993
ζ Virginis	13	0.46	2 24.38	50 47 24.38	39 13 0.20	43.24	39 13 43.44	0 0 1.30	44.74	+0.85	0.722
η Urs. Maj.	14	0.09	0 28.41	100 40 28.41	10 40 3.83	9.99	10 40 13.82	49 53 57.76	43.94	+1.65	2.722
α Coronæ	15	0.61	3 12.18	77 53 12.18	12 6 55.46	11.51	12 7 6.97	27 6 39.60	46.57	—0.98	0.960
α Serpentis	16	0.88	4 38.45	57 34 38.45	32 25 29.19	34.04	32 26 3.23	6 47 42.30	45.53	0.06	0.004
ε Serpentis	17	0.35	1 50.55	55 36 50.55	34 23 17.09	36.67	34 23 53.26	4 49 53.00	46.76	—1.17	1.369
δ Scorpii	18	0.13	0 40.18	28 30 40.18	61 29 27.46	98.26	61 31 5.72	—22 17 20.00	45.72	—0.13	0.017
β_1Scorpii	19	0.70	3 43.77	31 18 43.77	58 41 23.87	87.85	58 42 51.72	—19 29 6.30	45.42	+0.17	0.029
Groom^b. 2320	20	0.61	3 12.81	118 53 12.81	28 53 5.17	29.62	28 53 34.79	68 7 20.80	46.01	—0.42	0.176
τ Herculis	21	0.38	2 1.30	97 22 1.30	7 21 53.66	6.94	7 22 0.62	46 35 45.00	44.40	+1.19	1.416
η Draconis	22	0.57	2 59.29	112 32 59.29	22 32 51.65	22.29	22 33 13.94	61 46 59.32	45.38	+0.21	0.044
A Draconis	23	0.45	2 21.72	119 47 21.72	29 47 14.08	30.73	29 47 44.81	69 1 30.50	45.69	—0.10	0.010
η Herculis	24	0.05	0 17.32	89 55 17.32	0 4 50.32	0.08	0 4 50.40	39 8 55.46	45.86	—0.27	0.073
κ Ophiuchi	25	0.09	0 27.79	60 20 27.79	29 39 39.85	30.62	29 40 10.47	9 33 36.00	46.47	—0.88	0.774
d Herculis	26	0.17	0 55.74	84 30 55.74	5 29 11.90	5.17	5 29 17.07	33 44 30.10	47.17	—1.58	2.496

1883, JULY 13 — *Observer*, HENRY S. PRITCHETT. N_0 (27–34) = 270° 0′ 7″.24. M_0 (27–34) = $17^r.616$. B (27) = 29.058. B (28) = 29.054. B (29–30) = 29.064. B (31–34) = 29.006. T_a (27–30) = 76.0. T_a (31–34) = 75.5. T_e (27–29) = 68. T_e (30) = 67.5. T_e (31–33) = 66.5. T_e (34) = 66.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
α Serpentis	27	0.88	4 38.16	57 34 38.16	32 25 29.08	34.56	32 26 3.64	6 47 42.50	39 13 46.14	—0.55	0.302
ζ Urs. Min.	28	0.96	5 6.13	128 55 6.13	38 54 58.89	43.91	38.55 42.80	78 9 28.10	45.30	+0.29	0.084
β_1 Scorpii	29	0.71	3 44.51	31 18 44.51	58 41 22.73	89.19	58 42 51.92	—19 29 6.30	45.62	—0.03	0.001
Groom^b. 2320	30	0.60	3 11.72	118 53 11.72	28 53 4.48	30.04	28 53 34.52	68 7 21.20	46.68	—1.09	1.188
τ Herculis	31	0.38	2 0.78	97 22 0.78	7 21 53.54	7.06	7 22 0.60	46 35 45.45	44.85	+0.74	0.548
α Scorpii	32	0.58	3 2.26	24 38 2.26	65 22 5.54	118.38	65 24 3.36	—26 10 18.80	44.56	+1.03	1.061
A Draconis	33	0.44	2 20.84	119 47 20.84	29 47 13.60	31.24	29 47 44.84	69 1 30.90	46.06	—0.47	0.221
η Herculis	34	0.06	0 18.03	89 55 18.03	0 4 49.21	0.08	0 4 49.28	39 8 55.85	45.13	+0.46	0.212

1883, JULY 19 — *Observer*, HENRY S. PRITCHETT. N_0 (35–39) = 270° 0′ 5″.91. N_0 (40–46) = 270° 0′ 12″.90. M_0 (35–39) = $17^r.611$. M_0 (40–46) = $17^r.479$. B (35) = 29.268. B (36–37) = 29.270. B (38–39) = 29.272. B (40–41) = 29.266. B (42–46) = 29.260. T_a (35–37) = 80.5. T_a (38–39) = 80.0. T_a (40–46) = 77. T_e (35) = 83. T_e (36–37) = 82. T_e (38–39) = 81. T_e (40–41) = 76. T_e (42–46) = 75.5.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
α Bootis	35	0.80	4 12.65	70 34 12.65	19 25 53.26	18.80	19 26 12.06	19 47 31.35	39 13 44.19	+1.40	1.960
ε Bootis	36	0.13	0 42.20	78 20 42.20	11 39 23.71	11.01	11 39 34.72	27 34 10.07	44.79	+0.80	0.640
β Urs. Min.	37	0.75	3 57.92	125 23 57.92	35 23 52.01	37.92	35 24 29.93	74 38 14.23	44.30	+1.29	1.664
β Bootis	38	0.50	2 38.60	91 37 38.60	1 37 32.69	1.52	1 37 34.21	40 51 18.49	44.28	+1.31	1.716
β Libræ	39	0.05	0 15.82	41 50 15.82	48 9 50.09	59.66	48 10 49.75	— 8 57 5.54	44.21	+1.38	1.904
η Draconis	40	0.59	3 6.39	112 33 6.39	22 32 53.48	22.41	22 33 15.89	61 47 0.98	45.09	+0.50	0.250
ζ Ophiuchi	41	0.53	2 47.78	40 27 47.78	49 32 25.13	63.20	49 33 28.33	+10 19 42.34	45.99	—0.40	0.160
η Herculis	42	0.07	2 23.57	89 55 23.57	0 4 49.34	0.08	0 4 49.42	39 8 57.08	46.50	—0.91	0.828
κ Ophiuchi	43	0.10	0 32.85	60 20 32.85	29 39 40.06	30.76	29 40 10.82	9 33 37.12	47.94	—2.35	5.525
d Herculis	44	0.20	1 3.05	84 31 3.05	5 29 9.86	5.19	5 29 15.05	33 44 31.79	46.84	—1.25	1.562
a^1Herculis	45	0.66	3 30.43	65 18 30.43	24 41 42.48	24.84	24 42 7.32	14 31 39.35	46.67	—1.08	1.166
Groom^b. 966 s.p.	46	0.36	1 53.88	155 46 53.88	65 46 40.97	119.40	65 48 40.37	74 57 32.93	46.70	—1.11	1.232

1883, JULY 20 — *Observer*, HENRY S. PRITCHETT. N_0 (47–54) = 270° — 0′ — 8″.46. M_0 (47–54) = $17^r.590$. B (47–52) = 29.216. B (53) = 29.220. B (54) = 29.228. T_a (47–54) = 80. T_e (47–48) = 80. T_e (49–53) = 79. T_e (54) = 80.

STARS.	No.	E. Runs	Micsps.	C'	z	R	ζ	δ	φ	v	vv
		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	″
τ Herculis	47	0.39	2 3.56	97 22 3.56	7 21 55.10	6.91	7 22 2.01	46 35 46.82	39 13 44.81	+0.78	0.608
η Draconis	48	0.57	3 2.24	112 33 2.24	22 32 53.78	22.21	22 33 15.99	61 47 1.16	45.17	+0.42	0.176
A Draconis	49	0.46	2 25.36	119 47 25 36	29 47 16.90	30.67	29 47 47.57	69 1 32.34	44.77	+0.82	0.672
η Herculis	50	0.06	0 20.31	89 55 20.31	0 4 48.15	0.07	0 4 48.22	39 8 57.26	45.48	+0.11	0.012
κ Ophiuchi	51	0.09	0 29.69	60 20 29.66	29 39 38.80	30.51	29 40 9.31	9 33 37.24	46.55	—0.96	0.922
d Herculis	52	0.19	0 59.06	84 30 59.06	5 29 9.40	5.15	5 29 14.55	33 44 31.98	46.53	—0.94	0.884
α^1Herculis	53	0.65	3 25.90	65 18 25.90	24 41 42.56	24.64	24 42 7.20	14 31 39.50	46.70	—1.11	1.232
Groom.966sp	54	0.35	1 51.42	155 46 51.42	65 46 42.96	118.65	65 48 41.61	74 57 32.75	45.64	—0.05	0.002

1883, JULY 28 — *Observer*, C. W. PRITCHETT, JR. N_0 (55–60) = 269° 59′ 57″.59. N_0 (61–64) = 269° 59′ 45″.57. M_0 (55–60) = $17^r.854$. M_0 (61–64) = $18^r.141$. B (55–56) = 29.450. B (57–58) = 29.458. B (59–60) = 29.464. B (61–63) = 29.468. B (64) = 29.478. T_a (55–56) = 76.5. T_a (57–60) = 75.2. T_a (61–64) = 75.0. T_e (55–56) = 70. T_e (57–60) = 68.9. T_e (61–63) = 68. T_e (64) = 66.4.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ′	° ′ ″	° ′ ″	″	
κ Ophiuchi	55	0.07	0 21.49	60 20 21.49	29 39 36.11	31.27	29 40 7.38	9 33 38.20	39 13 45.58	+0.01	0.000
α^1Herculis	56	0.62	3 17.89	65 18 17.89	24 41 39.71	25.26	24 42 4.97	14 31 40.71	45.67	—0.08	0.006
b Ophiuchi	57	0.78	4 5.78	26 44 5.78	63 15 51.82	108.82	63 17 40.64	—24 3 55.40	45.24	+0.35	0.122
ω Draconis	58	0.90	4 44.04	119 34 44.04	29 34 46.44	31.26	29 35 17.70	68 49 2.20	44.50	+1.09	1.190
θ Herculis	59	0.47	2 30.32	88 2 30.32	1 57 27.26	1.89	1 57 29.15	37 16 17.81	46.96	—1.37	1.877
η Serpentis	60	0.26	1 21.51	47 51 21.51	42 8 24.07	49.89	42 9 13.96	2 55 27.90	46.06	—0.47	0.221
χ Draconis	61	0.30	1 35.80	123 26 35.80	33 26 50.22	36.44	33 27 26.66	72 41 13.39	46.73	—1.14	1.300
α Lyræ	62	0.34	1 48.76	89 26 48.76	0 32 56.82	0.53	0 32 57.35	38 40 50.24	47.55	—1.96	3.842
51 Cepheis p.	63	0.27	1 27.84	143 31 27.84	53 31 42.26	74.75	53 32 57.01	87 13 15.65	47.34	—1.75	3.062
50 Draconis	64	0.64	1 32.74	126 3 22.74	36 3 37.16	40.30	36 4 17.46	76 18 2.20	44.74	+0.84	0.706

1883, AUGUST 1 — *Observer*, C. W. PRITCHETT, JR. N_0 (65–71) = 269° 59′ 52″.73. N_0 (72–74) = 269° 59′ 51″.20. M_0 (65–71) = $18^r.033$. M_0 (72–74) = $18^r.052$. B (65–69) = 29.240. B (70–71) = 29.242. B (72–73) = 29.246. B (74) = 20.252. T_a (65–66) = 71.9. T_a (67–69) = 71.8. T_a (70) = 71.5. T_a (71–73) = 71. T_a (74) = 70.6. T_e (65–66) = 74.1. T_e (67–69) = 74. T_e (70.) = 73. T_e (71) = 70. T_e (72–74) = 68.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
σ Coronæ	65	0.14	0 45.09	84 55 45.09	5 4 7.64	4.80	5 4 12.44	34 9 34.46	39 13 46.90	—1.31	1.716
τ Herculis	66	0.35	1 49.52	97 21 49.52	7 21 56.79	7.04	7 22 3.83	46 35 48.62	44.79	+0.80	0.640
η Urs. Min.	67	0.42	2 13.47	126 47 13.47	36 47 20.74	40.47	36 48 0.21	76 1 46.22	46.01	—0.42	0.176
A Draconis	68	0.41	2 11.43	119 47 11.43	29 47 18.70	31.00	29 47 49.70	69 1 34.30	44.60	+0.99	0.980
η Herculis	69	0.02	0 7.39	89 55 7.39	0 4 45.34	0.08	0 4 45.42	39 8 59.26	44.68	+0.91	0.828
d Herculis	70	0.15	0 46.20	84 30 46.20	5 29 6.53	5.21	5 29 11.74	33 44 34.12	45.86	—0.27	0.073
α^1Herculis	71	0.61	3 14.21	65 18 14.21	24 41 38.52	25.09	24 42 3.61	14 31 41.28	44.89	+0.70	0.490
ι Herculis	72	0.08	0 25.65	96 50 25 65	6 50 34.46	6.58	6 50 41.04	46 4 27.81	46.77	—1.18	1.392
μ Herculis	73	0.74	3 55.39	78 33 55.39	11 25 55.80	11.08	11 26 6.88	27 47 39.70	46.58	—0.99	0.980
θ Herculis	74	0.46	2 25.46	88 2 25.46	1 57 25.73	1.87	1 57 27.60	37 16 18.66	46.26	—0.67	0.449

1883, AUGUST 3 — *Observer*, C. W. PRITCHETT, JR. N_0 (75–78) = 269° 59′ 48″.62. N_0 (79–81) = 269° 59′ 40″.26. M_0 (75–78) = $18^r.073$. M_0 (79–81) = $18^r.095$. B (75–77) = 29.438. B (78) = 29.446. B (79) = 29.442. B (80–81) = 29.450. T_a (75–77) = 69.7. T_a (78) = 69. T_a (79) = 68.7. T_a (80–81) = 68.5. T_e (75–77) = 61. T_e (78) = 58.9. T_e (79) = 57.2. T_e (80–81) = 56.5.

STARS.	No.	E. Runs	Micsps.	C'	z	R	ζ	δ	ϕ	v	vv
		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
d Herculis	75	0.13	0 41.28	84 30 41.28	5 29 7.34	5.37	5 29 12.71	33 44 34.40	39 13 47.11	—1.52	2.310
α^1 Herculis	76	0.59	3 8.04	65 18 8.04	24 41 40.58	25.70	24 42 6.28	14 31 41.42	47.70	—2.11	4.452
ϑ Herculis	77	0.02	0 5.24	25 55 5.24	64 4 43.38	114.80	64 6 38.18	—24 52 50.51	47.67	—2.08	4.326
ι Herculis	78	0.08	0 23.88	96 50 23.80	6 50 35.26	6.74	6 50 42.00	46 4 28.12	46.12	—0.53	0.281
λ Sagittarii	79	0.74	3 54.41	25 18 54.41	64 40 45.83	118.41	64 42 44.24	—25 28 56.98	47.26	—1.67	2.790
1 Aquilæ	80	0.50	2 39.02	42 27 39.02	47 32 1.22	61.56	47 33 2.78	— 8 19 16.14	46.64	—1.05	1.102
α Lyræ	81	0.34	1 46.08	89 26 46.08	0 32 54.46	0.55	0 32 54.71	38 40 51.64	46.35	—0.76	0.578

1883, AUGUST 6 — *Observer*, C. W. PRITCHETT, JR. N_0 (82–88) = 269° 59′ 50″.16. N_0 (89–94) = 269° 59′ 54″.74. M_0 (82–88) = $18^r.052$. M_0 (89–94) = $17^r.950$. B (82) = 29.468. B (83–84) = 29.470. B (87–90) = 29.468. B (91–92) = 29.462. B (93–94) = 29.472. T_a (82) = 71.6. T_a (83–84) = 71.5. T_a (85–86) = 70.8. T_a (87–92) = 70.6. T_a (93–94) = 70.5. T_e (82) = 70.9. T_e (83–84) = 69.0. T_e (85–86) = 67.5. T_e (87–88) = 67.3. T_e (89–92) = 67. T_e (93–94) = 66.5.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
α Camel^p s.p.	82	0.86	4 32 31	164 34 32.31	74 34 42.14	195.94	74 37 58.08	66 8 15.30	39 13 46.62	—1.03	1.061
ε Urs. Min.	83	0.81	4 11.74	132 59 11.74	42 59 21.57	51.32	43 0 12.89	82 13 59.74	46.85	—1.26	1.588
α^1 Herculis	84	0.60	3 9.82	65 18 9.82	24 41 40.35	25.33	24 42 5.68	14 31 41.78	47.76	—1.87	3.497
ϑ Ophiuchi	85	0.03	0 6.39	25 55 6.39	64 4 43.78	113.14	64 6 36.92	24 52 50.60	46.32	—0.73	0.533
α Ophiuchi	86	0.10	0 31.92	63 25 31.92	26 34 18.25	27.64	26 34 45.89	12 39 0.00	45.89	—0.30	0.090
ω Draconis	87	0.87	4 36.97	119 34 36.97	29 34 46.80	31.38	29 35 18.18	68 49 4.20	46.02	—0.43	0.185
ψ^1 Draconis	88	0.61	3 12.16	122 58 12.16	32 58 21.99	35.85	32 58 57.84	72 12 42.17	44.33	+1.26	1.588
o Herculis	89	0.28	1 29.48	79 31 29.48	10 28 25.26	10.23	10 28 35.49	28 45 8.42	43.91	+1.68	2.822
22 Camel^p s.p.	90	0.42	2 14.72	161 22 14.72	71 22 19.98	162.50	71 25 2.48	69 21 12.39	45.13	+0.46	0.212
δ Urs. Min.	91	0.42	2 6.72	137 22 6.72	47 22 11.98	59.95	47 23 11.93	86 36 56.80	44.87	+0.72	0.518
η Serpentis	92	0.29	1 31.11	47 51 31.11	42 8 23.63	50.00	42 9 13.63	— 2 55 27.18	46 45	—0.86	0.740
χ Draconis	93	0.34	1 47.26	123 26 47.26	33 26 52.52	36.56	33 27 29.08	72 41 15.70	46.62	—1.03	1.061
51 Cephei s.p.	94	0.31	1 39.66	143 31 39.66	53 31 44.92	74.76	53 32 59.68	87 13 13.30	47.03	—1.44	2.074

1883, AUGUST 8 — *Observer*, C. W. PRITCHETT, JR. N_0 (95–98) = 269° 59′ 50″.63. M_0 (95–98) = $18^r.029$. B (95–96) = 29.274. B (97–98) = 29.268. T_a (95–96) = 71.5. T_a (97–98) = 71.4. T_e (95–98) = 69.9.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
ϑ Herculis	95	0.46	2 27.63	88 2 27.63	1 57 23.01	1.87	1 57 24.88	37 16 19.95	39 13 44.83	+0.76	0.578
γ^2 Sagittarii	96	0.60	3 11.85	20 23 11.55	69 36 39.09	145.75	69 39 4.84	30 25 21.34	43.50	+2.09	4.368
o Herculis	97	0.27	1 24.98	79 31 24.98	10 28 25.66	10.10	10 28 35.76	28 45 8.79	44.55	+1 04	1.082
η Serpentis	98	0.27	1 26.32	47 51 26.32	42 8 24.32	49.40	42 9 13.72	— 2 55 27.03	46.69	—1.10	1.210

1883, AUGUST 16 — *Observer*, C. W. PRITCHETT, JR. N_0 (99–109) = 269° 59′ 51″.54. N_0 (110–112) = 269° 59′ 51″.63. M_0 (99–109) = $18^r.033$. M_0 (110–112) = $18^r.022$. B (99–102) = 29.338. B (103–106) = 29.340. B (107–111) = 29.344. B (112) = 29.346. T_a (99–104) = 75.4. T_a (105–106) = 75.2. T_a (107–109) = 75.0. T_a (110–112) = 74.9. T_e (99–100) = 74. T_e (101–104) = 73.2. T_e (105–106) = 71.5. T_e (107–109) = 71.2. T_e (110–111) = 70.9. T_e (112) = 70.2.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
β Draconis	99	0.87	4 34.82	103 9 34.82	13 9 43.29	12.70	13 9 55.99	52 23 40.04	39 13 44.05	+1.54	2.372
ι Herculis	100	0.09	0 29.86	96 50 29.86	6 50 38.33	6.52	6 50 44.85	46 4 31.23	46.38	—0.79	0.624
μ Herculis	101	0.75	3 58.32	78 33 58.32	11 25 53.21	11.00	11 26 4.21	27 47 42.06	46.27	—0.68	0.462

STARS.	No.	E. Runs	Mlcsps.	C'	z	R	ζ	δ	φ	v	vv
		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
ϑ Herculis	102	0.47	2 28.97	88 2 28.97	1 57 22.56	1.86	1 57 24.42	37 16 21.39	39 13 45.81	—0.22	0.048
γ^2 Sagittarii	103	0.60	3 8.92	20 23 8.92	69 36 42.61	145.40	69 39 8.01	—30 25 21.66	46.35	—0.76	0.578
22 Camel^p s.p.	104	0.42	2 14.62	161 22 14.62	71 22 23.09	160.00	71 25 3.09	69 21 10.87	46.04	—0.45	0.202
η Serpentis	105	0.29	1 28.05	47 51 28.05	42 8 23.48	49.37	42 9 12.85	— 2 55 26.47	46.38	—0.79	0.624
χ Draconis	106	0.34	1 48.96	123 26 48.96	33 26 57.43	36.06	33 27 33.49	72 41 18.01	44.52	+1.07	1.145
1 Aquilæ	107	0.54	2 51.06	42 27 51.06	47 32 0.47	59.61	47 33 0.08	— 8 19 15.54	44.54	+1.05	1.102
α Lyræ	108	0.38	2 1.30	89 27 1.30	0 32 50.23	0.52	0 32 50.75	38 40 54.49	45.24	+0.35	0.122
51 Cephei s p.	109	0.33	1 42.73	143 31 42.72	53 31 51.19	73.75	53 33 4.94	87 13 10.80	44.26	+1.31	1.716
ζ Aquilæ	110	0.63	3 18.43	64 28 18.43	25 31 33.19	26.13	25 31 59.32	13 41 46.15	45.47	+0.12	0.014
25 Camel^p s.p.	111	0.39	2 3.64	148 7 3.64	58 7 12.02	87.56	58 8 39.58	82 37 35.13	45.29	+0.30	0.090
d Sagittarii	112	0.61	3 14.51	31 38 14.51	58 21 37.11	88.55	58 23 5.66	—19 9 20.80	44.86	+0.73	0.533

1883. AUGUST 20 — *Observer*, C. W. PRITCHETT, JR. N_0 (113–121) = 269° 59′ 48″.27. M_0 (113–121) = $18^r.046$. B (113–116) = 29.260. B (117–118) = 29.256. B (119–120) = 29.262. B (121) = 29.258. T_a (113–114) = 74. T_a (114–121) = 73.8. T_e (113–114) = 69.3. T_e (115–116) = 69.5. T_e (117–121) $\doteq$ 69.1.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
χ Draconis R	113	0.54	2 51.06	236 32 51.06	33 26 57.21	36.10	33 27 33.21	72 41 18.93	39 13 45.62	—0.03	0.001
51 Cephei s.p.	114	0.31	1 38.26	143 31 38.26	53 31 49.99	73.81	53 33 3.80	87 13 10.00	46.20	—0.61	0.372
ζ Aquilæ	115	0.62	3 15.09	64 28 15.09	25 31 33.18	26.10	25 31 59.28	13 41 46.66	45.94	—0.35	0.122
d Sagittarii	116	0.61	3 11.42	31 38 11.42	58 21 36.85	88.41	58 23 5.26	—19 9 20.83	44.43	+1.16	1.346
τ Draconis R	117	0.09	0 29.44	236 5 29.44	33 54 18.83	36.74	33 54 55.57	73 8 41.88	46.31	—0.72	0.518
β Cygni	118	0.85	4 30.72	78 29 30.72	11 30 17.55	11.13	11 30 28.68	27 43 16.45	45.13	+0.46	0.212
κ Aquilæ	119	0.02	0 8.33	43 30 8.33	46 29 39.94	57.57	46 30 37.51	7 16 52.58	44.93	+0.66	0.436
λ Urs. Min.	120	0.50	2 25.81	139 42 25.81	49 42 37.54	64.43	49 43 41.97	88 57 26.31	44.34	+1.25	1.562
τ Aquilæ	121	0.74	3 55.11	57 43 55.11	32 5 53.16	34.53	32 6 27.69	6 57 17.46	45.15	+0.44	0.194

1883. AUGUST 21 — *Observer*, C. W. PRITCHETT, JR. N_0 (122–130) = 269° 59′ 55″.54. M_0 (122–130) = $17^r.921$. B (122–123) = 29.142. B (124) = 29.146. B (125–126) = 29.152. B (127–130) = 29.162. T_a (122–123) = 80.8. T_a (124–126) = 80.5. T_a (127–130) = 80.3. T_e (122–123) = 81.5. T_e (124–126) = 81.2. T_e (127–128) = 81. T_e (129–130) = 80.5.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
μ Herculis R	122	0.15	0 47.95	281 25 47.95	11 25 53.45	10.76	11 26 3.21	27 47 42.64	29 13 45.85	—0.26	0.068
γ Draconis R	123	0.61	3 17.40	257 43 17.40	12 16 38.01	11.32	12 16 49.33	51 30 34.64	45.31	+0.28	0.078
δ Urs. Min.	124	0.42	2 13.22	137 22 13.22	47 22 17.72	57.77	47 23 15.49	86 36 59.80	44.31	+1.28	1.638
η Serpentis	125	0.28	1 29.78	47 51 29.78	42 8 25.72	48.14	42 9 13.86	2 55 26 16	47.70	—2.11	4.452
χ Draconis	126	0.36	1 54.68	123 26 54.68	33 26 59.18	35.16	33 27 34.34	72 41 19.13	44.79	+0.80	0.640
α Lyræ	127	0.40	2 4.86	89 27 4.86	0 32 50.64	0.51	0 32 51.15	38 40 55.42	46.51	—0.98	0.960
51 Cephei s.p.	128	0.34	1 47.61	143 31 47.61	53 31 52.11	71.93	53 33 4.04	87 13 9.75	46.21	—0.62	0.384
γ Lyræ	129	0.65	3 27.02	83 18 27.02	6 41 28.48	6.27	6 41 34.75	32 32 11.14	45.89	—0.30	0.090
ι Lyræ	130	0.32	1 40.29	86 41 40.29	3 18 15.21	3.08	3 18 18.29	35 55 26.24	44.53	+1.06	1.124

1883, AUGUST 23 — *Observer*, C. W. PRITCHETT, JR. N_0 (131–136) = 269° 59′ 46″.20. N_0 (137–142) = 269° 59′ 53″.94. M_0 (131–136) = $18^r.143$. M_0 (137–142) = $17^r.951$. B (131) = 29.404. B (132) = 29.410. B (133–134) = 29.418. B (135–136) = 29.424. B (137–140) = 29.430. B (141–142) = 29.432. T_a (131) = 69.9. T_a (132) = 69.4. T_a (133–134) = 69.1. T_a (135–136) = 69.0. T_a (137–142) = 68.0. T_e (131) = 66.0. T_e (132) = 63.9. T_e (133–136) = 62.1. T_e (137–140) = 58.5. T_e (141–142) = 58.8.

		″	′ ′	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
ϑ Herculis	131	0.46	2 24.00	88 2 24.00	1 57 22.20	1.89	1 57 24.09	37 16 22.37	39 13 46.46	—0.87	0.757
γ^2 Sagittarii	132	0.59	3 7.56	20 22 7.56	69 36 38.64	148.13	69 39 6.77	—30 35 21.88	44.89	+0.70	0.490
δ Urs. Min.	133	0.38	1 59.55	137 21 59.55	47 22 13.35	60.49	47 23 13.84	86 37 0.20	46.36	—0.77	0.593

STARS.	No.	E. Runs	Micsps.	C′	z	R	ζ	δ	φ	v	vv
		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
η Serpentis	134	0.27	1 25.56	47 51 25.56	42 8 20.64	50.49	42 9 11.13	— 2 55 26.20	39 13 44.93	+0.66	0.436
χ Draconis R	135	0.53	2 48.15	236 32 48.15	33 26 58.62	36.88	33 26 35.50	72 41 19.58	44.08	+1.51	2.280
51 Cephei s.p.	136	0.30	1 35.02	143 31 35.02	53 31 48.82	75.41	53 33 4.23	87 13 9.30	45.07	+0.52	0.270
ι Lyræ	137	0.32	1 40.75	86 41 40.75	3 18 13.19	3.24	3 18 16.43	35 55 27.68	44.11	+1.48	2.190
25 Camel^p s.p.	138	0.39	2 3.61	148 7 3.61	58 7 9.67	90.03	58 8 39.70	82 37 34.26	46.04	—0.45	0.202
ϑ Lyræ	139	0.40	2 7.97	88 42 7.97	1 17 45.97	1.27	1 17 47.24	37 55 58.51	45.81	—0.22	0.048
τ Draconis R	140	0.11	0 33.73	236 5 33.73	33 54 20.21	37.73	33 54 57.94	73 8 42.66	44.72	+1.87	0.759
κ Aquilæ	141	0.05	0 14.67	43 30 14.67	46 29 39.27	59.06	46 30 38.33	— 7 16 52.46	45.87	—0.28	0.078
λ Urs. Min.	142	0.47	2 29.37	139 42 29.37	49 42 35.43	66.11	49 43 41.54	88 57 27.20	45.66	—0.07	0.005

1883, August 29 — *Observer*, C. W. Pritchett, Jr. N_0 (143–149) = 270° 0′ 2″.37. N_0 (150) = 269° 59′ 53″.52. M_0 (143–149) = $17^r.827$. M_0 (150) = $18^r.066$. B (143–144) = 29.316. B (145–146) = 29.324. B (147–150) = 29.332. T_a (143–144) = 72.6. T_a (145–148) = 72.5. T_a (149–150) = 72.1. T_e (143–148) = 68. T_e (149) = 66.9. T_e (150) = 65.6.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
η Serpentis	143	0.31	1 38.38	47 51 38.38	42 8 23.98	49.65	42 9 13.63	— 2 55 25.92	39 13 47.71	—1.12	1.254
λ Sagittarii	144	0.81	4 15.30	25 19 15.30	64 40 47.06	115.45	64 42 42.51	25 28 57.59	44.92	+0.67	0.449
1 Aquilæ	145	0.57	3 0.47	42 28 0.47	47 32 1.89	59.94	47 33 1.83	— 8 9 15.04	46.79	—1.20	1.440
α Lyræ	146	0.42	2 13.39	89 27 13.39	0 2 48.97	0.53	0 2 49.50	38 40 56.76	46.26	—0.67	0.449
51 Cephei s.p.	147	0.36	1 53.76	143 31 53.76	53 31 51.40	73.99	53 33 5.39	87 13 8.00	46.61	—1.02	1.040
25 Camel^p s.p.	148	0.44	2 18.36	148 7 18.36	58 7 16.00	88.05	58 8 44.05	82 37 32.17	43.78	+1.81	3.276
τ Draconis R	149	0.13	0 41.78	236 5 41.78	33 54 20.58	36.99	33 54 57.57	73 8 44.14	46.57	—1.98	3.920
ϑ Aquilæ	150	0.48	2 33.13	310 22 33.13	40 22 39.61	46.87	40 23 26.48	— 1 9 41.20	45.28	+0.31	0.096

1883, August 31 — *Observer*, C. W. Pritchett, Jr. N_0 (151–161) = 269° 59′ 54″.38. M_0 (151–161) = $17^r.942$. B (151–152) = 29.344. B (153–156) = 29.346. B (157–158) = 29.350. T_a (151–152) = 75.3. T_a (153–158) = 75.0. T_a (159–161) = 29.354. T_e (151–152) = 74.9. T_e (153–154) = 74.2. T_e (155–156) = 74.0. T_e (157–158) = 73.9. T_e (159–160) = 73.2. T_e (161) = 72.9.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
1 Aquilæ	151	0.54	2 52.94	42 27 52.94	47 32 1.44	59.19	47 33 0.63	8 19 15.02	39 13 45.61	—0.02	0.000
51 Cephei s.p.	152	0.34	1 47.49	143 31 47.49	53 31 53.11	73.24	53 33 6.35	87 13 7.75	45.90	—0.31	0.096
50 Draconis	153	0.70	3 41.55	126 3 41.55	36 3 47.17	39.48	36 4 26.65	75 18 10.76	44.11	+1.48	2.190
ζ Aquilæ	154	0.64	3 21.92	64 28 21.92	5 31 32.46	25.94	5 31 58.40	13 41 47.88	46.28	—0.69	0.476
25 Camel^p s.p.	155	0.41	2 10.73	148 7 10.73	58 7 16.35	87.12	58 8 43.47	82 37 31.84	44.79	+0.80	0.640
d Sagittarii	156	0.62	3 17.12	31 38 17.12	58 21 37.26	87.92	58 23 5.18	—19 9 20.98	44.20	+1.39	1.937
τ Draconis	157	0.81	4 17.81	123 54 17.81	33 54 23.43	36.53	33 54 59.96	73 8 44.54	44.58	+1.01	1.020
β Cygni	158	0.88	4 38.75	78 29 38.75	11 30 15.63	11.07	11 30 26.70	27 43 18.82	45.52	+0.07	0.005
β Sagittæ	159	0.83	4 16.38	67 59 16.38	22 0 38.00	22.01	22 1 0.01	17 12 44.99	45.00	+0.59	0.348
λ Urs. Min.	160	0.48	2 35.36	139 42 35.36	49 42 40.98	64.12	49 43 45.10	88 57 29.40	44.30	+1.29	1.664
τ Aquilæ	161	0.76	4 1.54	57 44 1.54	32 15 52.84	34.38	32 16 27.22	6 57 18.60	45.82	—0.23	0.053

1883, September 3 — *Observer*, C. W. Pritchett, Jr. N_0 (162–167) = 270° 0′ 5″.86. M_0 (162–167) = $17^r.738$. N_0 (168–170) = 269° 59′ 58″.12. M_0 (168–170) = $17^r.905$. B (162–163) = 29.388. B (164–167) = 29.390. B (168–170) = 29.398. T_a (162) = 75.5. T_a (163) = 75.2. T_a (164–167) = 74.9. T_a (168–170) = 74.5. T_e (162) = 71.5. T_e (163) = 70.2. T_e (164–167) = 69.9. T_e (168–170) = 69.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ′	″	
α Lyræ	162	0.44	2 18.39	89 27 18.39	0 32 47.47	0.52	0 32 47.99	38 40 57.41	39 13 45.40	+0.19	0.036
51 Cephei s.p.	163	0.38	1 58.49	143 31 58.49	53 31 52.63	73.99	53 33 6.62	87 13 7.30	46.08	—0.49	0.240
ζ Aquilæ R	164	0.30	1 37.22	295 31 37.22	25 31 31.36	26.23	25 31 57.59	13 41 48.13	45.72	—0.13	0.017
25 Camel^p s.p.	165	0.40	2 19.84	148 7 19.84	58 7 13.98	88.04	58 8 42.02	82 37 31.34	46.64	—1.05	1.102

STARS.	No.	E. Runs	Micsps.	C'	z	R	ζ	δ	ϕ	v	vv
		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
τ Draconis R	166	0.13	0 41.73	236 5 41.73	33 54 24.13	36.91	33 55 1.04	73 8 45.27	39 13 44.23	+1.36	1.850
λ Urs. Min.	167	0.51	2 44.40	139 42 44.40	49 42 38.54	64.69	49 43 43.23	88 57 30.00	46.77	—1.18	1.392
τ Aquilæ	168	0.16	0 49.53	302 15 49.53	32 15 51.41	34.68	32 16 26.09	6 57 18.90	44.99	+0.60	0.360
o_1Cygni	169	0.91	4 48.81	97 9 48.81	7 9 50.69	6.91	7 9 57.60	46 23 41.97	44.37	+1.22	1.488
γ Cygni	170	0.88	4 39.28	90 39 39.28	0 39 41.16	0.63	0 39 41.79	39 53 26.41	44.62	+0.97	0.941

1883, SEPTEMBER 5 — *Observer*, C. W. PRITCHETT, JR. N_0 (171–177) = 269° 59′ 59″.30. M_0 (171–177) = 17ʳ.530. B (171–172) = 29.524. B (173–175) = 29.528. B (176–177) = 29.530. T_a (171–173) = 68.4. T_a (173–175) = 67.9. T_a (176–177) = 67.2. T_e (171–172) = 60.3. T_e (173–175) = 58.0. T_e (176–177) = 57.2.

		″	′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	″	
β Sagittæ	171	0.84	4 23.85	67 59 23.85	22 0 35.45	22.70	22 0 58.15	17 12 45.54	39 13 43.69	+1.90	3.610
λ Urs. Min.	172	0.49	2 36.56	139 42 36.56	49 42 37.26	66.12	49 43 33.38	88 57 30.50	47.12	—1.53	2.341
o_1Cygni R	173	0.02	0 8.57	262 50 8.57	7 9 50.73	7.09	7 9 57.82	46 23 42.44	44.62	+0.97	0.941
γ Cygni	174	0.88	4 39.70	90 39 40.40	0 39 40.40	0.65	0 39 41.05	39 53 26.89	45.84	—0.25	0.062
α Cygni	175	0.64	4 22.94	95 38 22.94	5 38 23.64	5.57	5 38 29.21	44 52 15.06	46.85	—1.26	1.588
ε Cygni	176	0.70	3 43.77	84 18 43.77	5 41 15.53	5.62	5 41 21.15	33 32 25.57	46.72	—1.13	1.277
ν Cygni	177	0.87	4 42.66	91 29 42.66	1 29 43.36	1.48	1 29 44.84	40 43 31.04	46.20	—0.61	0.372

Results from Second Series. The mean value of ϕ, resulting from the second series of observations, is $\phi = 39° \, 13' \, 45''.59$. The sum of the squares of the residuals $= [vv] = 187.757$. Hence the probable error of a single observation is $\pm 0''.70$; and the probable error of the arithmetic mean is $\pm 0''.05$. Hence, finally, $\phi = 39° \, 13' \, 45''.59 \pm 0''.05$.

It will be seen on comparison, that the probable error of any single observation, in the second series, is a little more than twice as great as in the first. Several reasons may be assigned for this. *First*, the earlier and later observations are by different observers. *Second*, there is room for a much wider range of error in the assumed star places, extending as they do from the pole to 120° of north polar distance; while the stars of the former series are limited to four in the immediate vicinity of the pole. *Third*, the anomalies of refraction must necessarily have greater influence in the second series. Comparing the actually occurring errors of the series with those demanded by theory, it will be seen that the errors do not run quite so smoothly as in the former series.

Number of errors demanded by theory, less than	$\frac{1}{2} r$	r	$\frac{3}{2} r$	$2 r$	$\frac{5}{2} r$	$3 r$
=	47	88	122	146	161	170
Number of errors actually occurring, =	36	69	115	152	163	174

The error standing exactly in the middle place of all the errors, in order of magnitude, is 0.84; which by theory should be equal to the probable error. Notwithstanding these variations in the distribution of errors, the mean result and its probable error is identical with that of the former series. This is due to the larger number of observations.

MEASURES OF DOUBLE STARS.

The following list contains the measures of double stars made during parts of the years 1880–81, while Mr. Henry S. Pritchett was connected with the Observatory. It contains no other stars except six or eight measured by him in the summer of 1884, and a few by myself in 1882. Another list of miscellaneous stars, previously measured, appears in another part of this publication.* This catalogue contains but a small fraction of the work in this field which was planned. The intention at starting was to remeasure nearly all the double stars of Σ, OΣ, H_1, H_2 and β, for which previous measures were insufficient to determine the nature and progress of the motion, using in the selection of such stars the suggestions and comparisons of other observers. Of special use in this selection were the *Catalogue Étoiles Doubles et Multiples*, par Flammarion; the *Handbook of Double Stars*, by Crossley, Gledhill & Wilson; the Publications of the Cincinnati Observatory; the Catalogue of Prof. Hall; and the various Catalogues of Mr. Burnham. Two very potent causes served to frustrate, in a large measure, our original plan. One was the prevalence of unfavorable weather for much the greater part of the time. Many of the doubles selected required the best atmospheric conditions. Such opportunities were rarely afforded us; and often on account of "poor seeing," we had to accept wide in place of close pairs previously selected. In the second place, the work was prematurely terminated by the acceptance of Mr. H. S. Pritchett of the Professorship of Astronomy and Mathematics in Washington University, St. Louis, Mo. From the first, the selection of stars, mode of observation, and the reductions, had been under his special charge; and, since he left us, the remaining force of the Observatory has been fully employed in other directions.

The mean results of the observations are here given in position, angle and angular distance, in the columns headed *p* and *s*, while the number of independent measures of angle and double distance is given in the columns headed p_n and s_n, and the number of nights in the column headed *Ns.* The observers are indicated in the column headed O. — P. standing for C. W. Pritchett, H. for Henry S. Pritchett, and C. for C. W. Pritchett, Jr. The weight assigned is estimated from the definition, steadiness of the images, stillness of the air, absence of haze, etc. It is rather an estimate of the conditions than of the observation itself, made on a scale from 1 to 5.

It was intended to publish with the observations an investigation of the personal equation of the observers, and a comparison of their observations with those of other double star observers. We are not insensible to the value of such a comparison. This work was taken in hand by Mr. H. S. Pritchett, who has not yet found opportunity to complete it. Perhaps the curtailment of the work, and the limited number of observations, may make the comparison the less necessary. Much has been said and written of late years about the position of the line of the eyes, relative to the line joining the stars. In these measures we simply chose that position of the eyes least straining and most natural. In measuring stars separated 7″ or more, it was usual to employ the power *C*, magnifying 275 times; for stars from 2″ to 7″ the power *D* was generally used, magnifying 400 times; for stars less than 2″ a periscopic eye-piece, by Gundlach, was generally used, magnifying 600 times; and in a few instances, for stars less than 1″, the power *E* was employed, magnifying 800 times. For all the fainter stars, the wires were directly illuminated by a red light, modified at pleasure by a screen. For the brighter and wider pairs, a bright field with dark wires was generally used. The stars, with two or three exceptions, are arranged in the order of their approximate right ascension, for 1880.0.

While sensible of some discordances in these observations, I think as a whole they have a real value, and I submit them as they are — a small contribution in the boundless field of double star work.

For those unacquainted with double star work, some brief notes are subjoined, showing only general results; and for these it may be well to add, that H_1 and H_2 denote respectively Sir William and Sir John Herschel, Σ denotes F. G. W. Struve, *O*Σ Otto Struve, So. Sir James South, while β is Mr. Burnham's chosen symbol.

C. W. Pritchett.

No.	M. Date.	Designations of Stars.	1880.0		O.	p_n	s_n	N_s.	p	s	wt.	Notes.
			R. A.	N. P. D.								
			h. m.	° ′								
1	1881.864	Σ 3063	0 1.5	95 12	P	10	6	3	212.96	1.81	3	p has dec. 20° since 1833. s nearly same as in 1831.
2	81.807	Σ 8, 27 Ceti	0 5.4	93 45	P	10	10	3	292.30	8.01	3	Very little change in 50 years.
3	81.869	OΣ 2, $\frac{AB}{2}$ and C	0 7.4	63 40	P	3	3	1	222.16	17.55	3	p has dec. 4° since 1814. s nearly same as in 1814.
4	81.861	Σ 23	0 11.3	90 21	P	9	9	3	346.02	7.94	3	p has dec. 15° since 1825. s has dec. 6″ since 1825.
5	81.806	Σ 35	0 25.5	92 43	P	13	14	4	263.43	8.59	3	p has dec. 5° since 1830. s nearly same.
6	81.978	Σ 44	0 31.9	49 40	P	9	9	3	264.05	9.21	3	p has inc. 5° since 1830. s has inc. 1″.3.
7	81.817	Σ 49	0 34.7	97 54	P	10	10	3	319.99	6.15	2.5	s has inc. 1″.6 since 1831. p nearly same as 1831.
8	81.913	OΣ 18	0 36.1	86 29	P	6	7	2	122.09	1.29	2.5	p has inc. 31° since 1843. s nearly constant.
9	81.803	Σ 51	0 37.3	73 18	P	6	6	2	129.38	4.30	3	p has dec. very little since 1831.
10	82.042	Σ 52	0 37.5	44 26	P	7	7	2	10.41	1.85	3	p has dec. 15° since 1831. s inc. very slowly.
11	82.084	Σ 59	0 41.2	39 13	P	9	9	3	153.96	2.53	3	p has inc. 13° since 1783. s changes very little.
12	81.724	Σ 60 η Cassiop.	0 41.8	32 49	P	10	9	3	161.37	5.12	3	p has inc. 91° since 1780.
12	81.724	Σ 60 η Cassiop.	0 41.8	32 49	C	8	8	3	161.36	5.27	3	s has dec. 6″ since 1780.
13	81.822	Σ 67	0 45.9	80 3	P	10	9	3	360.67	1.81	2.5	p has dec. 13° since 1831. s inc. very slowly.
14	81.896	So. 390	0 52.2	106 20	P	9	9	3	211.65	6.58	3	p has inc. 180° since 1824. s has dec. 1″.2 since 1824.
15	81.776	Σ 80	0 53.2	89 52	P	3	3	1	313.95	20.44	2.5	p has inc. 17° since 1822. s has inc. 1″.6.
16	81.963	Σ 86	0 58.7	96 7	P	10	10	3	159.97	12.71	3	p has dec. 20° since 1783. s probably inc. very slowly.
17	82.025	Σ 88	0 59.0	69 10	P	9	9	3	159.28	29.98	3	Almost no change since 1832.
18	81.861	Σ 87	0 59.1	75 15	P	9	9	3	193.10	6.51	3	Very little change since 1829.
19	81.967	Σ 91	1 1.0	92 23	P	9	9	3	319.78	4.03	3	p has dec. 8° since 1831. s varies very little.
20	82.105	β 236	1 5.0	43 39	P	3	3	1	113.97	5.91	3	
21	81.967	Σ 122	1 20.7	87 5	P	9	9	3	327.28	6.19	3	p has dec. 5°.5 since 1833. s probably inc. very slowly.
22	81.957	Σ 171	1 42.6	92 2	P	8	8	2	159.48	29.73	3	p probably inc. very slowly. s has inc. 1″.8 since 1830.
23	82.120	Σ 170	1 44.3	14 22	P	9	9	3	248.18	3.05	3	No change since 1831.
24	81.815	Σ 180 γ Arietis	1 47.0	71 18	P	3	4	1	175.63	8.62	3	Change imperceptible in 50 years.
25	82.120	Σ 191	1 52.5	16 44	P	9	9	3	191.32	5.45	3	No change since 1832.
26	82.163	Σ 202, α Piscium	1 55.8	87 49	P	4	4	1	321.90	3.40	3	p has dec. 15° since 1822. s changes very little.
27	81.728	Σ 262, ι Cassiop.	2 19.2	23 9	P	6	6	2	260.90	2.02	3	p has dec. 29° since 1782. s nearly constant.
27	81.728	Σ 262 AC	2 19.2	23 9	P	6	6	2	110.40	7.59	3	p has inc. 10° in 100 years. s has changed little.
28	81.001	Σ 355	3 1.0	82 4	H	3	3	1	146.08	2.11	2.5	p has dec. 3° since 1832. s is probably dec. slowly.
29	81.001	Σ 407	3 24.3	101 32	H	3	3	1	44.22	2.71	2.5	p has inc. 5° since 1833. s is probably increasing.
30	81.184	Σ 459	3 43.6	60 43	H	3	3	1	327.04	16.11	3	p has inc. 9° since 1831 s has inc. 3″.3 since 1831.
31	81.028	H$_2$ 1408	3 44.2	128 0	H	3	3	1	206.03	6.93	2	p has inc. 7° since 1836. s has dec. 2″ since 1836.
32	81.148	OΣ 78	4 8.7	60 18	H	3	3	1	248.72	2.36	3	p has inc. 5°.5 since 1847.
33	81.028	Σ 536	4 16.2	94 58	H	2		1	158.96		2	p has inc. 10° since 1831.
34	81.124	Σ 596	4 40.3	102 10	H	3	3	1	284.93	10.36	3	p has inc. 4° since 1831. s changes very little.
35	81.143	H$_2$ 3752 AB	5 16.8	124 54	H	9	8	3	103.39	2.60	3	p has inc. 3°.5 since 1835. s has dec. 1″.5 since 1835.
35	81.143	H$_2$ 3752 AC	5 16.8	124 54	H	3		1	105.42		2	
36	80.367	β Leporis	5 23.1	110 51	H	13	10	3	288.28	2.77	3	p probably inc. slowly. s probably dec. slowly.
36	81.148	β Leporis	5 23.1	110 51	H	3		1	288.02		2	
36	80.171	β Leporis	5 23.1	110 51	P	3	2	1	287.24	2.68	3	
37	81.148	Anonymous BC	5 31.8	89 58	H	3	3	1	131.21	6.54	2	Near Σ 782.
37	81.148	" $\frac{BC}{2}$ and A	5 31.8	89 58	H	3		1	127.75		2	
38	81.146	Σ 782	5 36.5	90 1	H	3	6	2	307.81	39.69	2.5	p dec. very slowly. s inc. 3″ in 50 years.
39	80.470	Σ 826	5 32.8	91 20	H	10	8	3	122.95	2.18	2.5	p has inc. 7° since 1832. s inc. very slowly.
40	81.146	H$_2$ 3823	5 55.9	121 4	H	3	3	1	122.97	2.88	3	p has dec. 7° since 1837. s has dec. 2″ since 1837.
41	81.678	Σ 859	6 3.2	84 19	H	7	6	2	247.06	34.85	3	p dec. very slowly. s has inc. 3″.6 in 82 years.
42	80.176	Σ3116 33 Monoc.	6 15.9	101 42	H	7	6	2	22.22	3.96	3	p inc. 4° in 50 years. s varies very little.
42	80.206	Σ3116 33 Monoc.	6 15.9	101 42	P	3	3	1	25.03	4.13	3	
43	80.205	OΣ 140	6 19.7	74 24	H	3	3	1	119.76	2.55	2	p has dec. 5° in 37 years. s changes imperceptibly.
44	80.193	Σ 910	6 20.6	89 28	H	6	6	2	165.25	1.04	3	p has dec. 5° in 50 years. s probably increases slowly.
45	80.194	Sirius	6 39.7	106 32	H	26	20	6	47.26	10.11	4	
45	80.142	Sirius	6 39.7	106 32	P	5	5	3	48.02	10.63	3	Both p and s dec. rapidly.
45	81.180	Sirius	6 39.7	106 32	H	15	10	5	44.17	9.87	3	
45	81.154	Sirius	6 39.7	106 32	P	6	6	2	44.42	10.01	3	
45	82.123	Sirius	6 39.7	106 32	P	24	24	4	43.05	9.49	4	
46	80.215	Σ 955 AB	6 35.4	97 52	H	4	3	1	273.77	1.08	3	Movement very uncertain.

No.	M. Date.	Designations of Stars.	1880.0		O.	p_n	s_n	*Ns.*	*p*	*s*	*wt.*	Notes.
			R. A.	N. P. D.								
			h. *m.*	° ′								
46	1880.215	Σ 955 $\frac{AB}{2}$ and C	6 35.4	97 52	H	4	3	1	188.76	11.54	3	c is a faint companion of *C*.
46	80.215	Σ 955 Cc	6 35.4	97 52	H	1	est	1	167.25	14.00	2	Also, for *cd.*, p = 40°, s = 5″.0, mag. 12.5.
47	80.558	OΣ 165, 45 Gem.	7 1.5	73 52	H	11	6	3	73.12	2.73	2	*p* has dec. 58° since 1847. *s* prob. dec. slowly. AC *p* = 340° *s* = 28″.
48	80.245	Anonymous	7 7.1	75 11	H	3	3	1	222.11	9.12	3	
49	80.242	Σ 1047	7 7.4	74 1	H	4	3	1	23.92	21.83	3	
49	80.244	Σ 1047	7 7.4	74 1	P	7	6	2	22.31	22.11	3	*p* and *s* increase slowly.
50	80.191	Σ 1049	7 8.0	98 43	H	8	6	2	43.04	3.61	3	
50	80.200	Σ 1049	7 8.0	98 43	P	8	6	2	40.50	3.34	3	*p* has inc. 8° since 1830. *s* varies very little.
51	81.184	β 757	7 8.2	126 20	H	3	3	1	65.81	2.25	3	
52	80.250	Σ 1046	7 7.8	75 14	H	13	12	4	235.70	11.25	2	*p* increases slowly. *s* probably dec. slowly.
53	81.184	Anonymous	7 12.0	126 20	H	3	3	1	210.36	2.57	3	Near β 757.
54	80.215	Σ 1074	7 14.3	89 22	H	3	est	1	130.17	0.60	2	*p* has inc. 20° in 55 years. *s* is doubtful.
55	80.163	Σ 1104	7 24.0	104 44	H	7	7	2	320.72	2.58	3	
55	80.164	Σ 1104	7 24.0	104 44	P	7	6	2	321.33	2.63	3	*p* has inc. 29° in 45 years. *s* is prob. increasing.
56	80.158	Σ 1132	7 36.2	93 14	H	8	6	2	237.66	19.75	3	*p* has dec. 12° since 1783. *s* is inc. slowly.
56	80.173	Σ 1132	7 36.2	93 14	P	3	3	1	234.02	19.48	3	
57	80.445	OΣ 182	7 46.4	86 18	H	12	10	4	39.92	1.24	3	*p* has dec. 7° in 27 years.
58	80.531	Σ 1157	7 48.5	92 28	H	10	11	3	253.31	1.37	3	*p* has dec. 14° since 1831. *s* changes little.
58	80.184	Σ 1157	7 48.5	92 28	P	3	3	1	254.30	1.35	3	
59	80.170	Σ 1175	7 56.1	85 30	H	6	10	3	220.10	2.18	3	*p* has inc. 20° since 1825. *s* is prob. dec. very slowly.
59	80.171	Σ 1175	7 56.1	85 30	P	3	3	1	221.52	2.14	3	
60	80.165	Σ 1179	7 58.1	77 35	H	4	3	1	204.17	19.51	3	*p* has dec. 2° since 1829. *s* has inc. 2″ since 1829.
60	80.209	Σ 1179	7 58.1	77 35	P	6	6	2	202.86	19.53	3	
61	81.311	Σ 1187	8 2.0	57 25	H	6	6	2	51.99	2.02	3	*p* has dec. 22° in 52 years. *s* increases very slowly.
61	81.304	Σ 1187	8 2.0	57 25	P	3	3	1	50.53	2.16	3	
62	81.313	Σ 1196 ζ Canc. AB	8 5.3	71 59	H	6	6	2	80.51	0.73	3	Very remarkable system. B revolves round A in about 60 years. Its motion is much affected by the attraction of C. C has an angular velocity of about 30° in 60 years. The motions of the three bodies very complex, and of the deepest interest.
62	81.310	Σ 1196 ζ Canc. AB	8 5.3	71 59	P	3	3	1	67.21	0.81	3	
62	81.313	Σ 1196 ζ $\frac{AB}{2}$ and C	8 5.3	71 59	H	6	6	2	131.07	5.36	3	
62	81.310	Σ 1196 ζ $\frac{AB}{2}$ and C	8 5.3	71 59	P	3	3	1	133.01	5.77	3	
63	81.310	Anonymous	8 7.1	74 0	H	3	3	1	345.69	1.11	3	
64	80.555	Σ 1213	8 11.5	83 10	H	10	9	3	322.46	7.49	3	*p* has dec. 6° since 1831. *s* probably dec. slowly.
64	80.248	Σ 1213	8 11.5	83 10	P	3	3	1	321.17	8.37	3	
65	81.343	Σ 1243	8 27.7	88 0	H	6	6	2	228.50	1.76	2.5	*p* has inc. 7° in 50 years.
66	80.246	β 206	8 30.3	114 42	H	6	6	2	280.13	1.42	3	
66	80.269	β 206	8 30.3	114 42	P	3	3	1	278.85	1.82	3	
67	80.275	β 207	8 33.7	109 19	H	4	4	1	101.97	4.06	2	
68	81.287	β 209	8 35.4	50 46	H	7	6	3	357.72	1.43	2.5	
69	80.269	Σ 1287 AB	8 44.9	77 25	H	9	6	3	88.58	1.56	3	*p* has dec. 21° in 50 years. *s* changes very little.
69	80.239	Σ 1287 AC	8 44.9	77 25	H	2		1	112.25		2	
70	80.334	Σ 1295, 17 Hydræ	8 49.0	97 29	H	13	12	4	359.59	4.18	3	Very little change in 50 years.
70	80.222	Σ 1295, 17 Hydræ	8 49.0	97 29	P	7	6	2	358.65	4.19	3	
71	80.760	β 103	8 49.0	97 21	H	4	6	2	73.70	2.71	3	
72	81.301	Σ 1296	8 51.8	54 35	H	9	6	3	76.82	2.48	3	*p* has inc. 5° in 50 years.
72	81.304	Σ 1296	8 51.8	54 35	P	3	3	1	76.53	2.62	3	
73	81.306	Σ 1300	8 54.6	74 15	H	6	6	2	201.78	4.86	3	*p* has dec. 9° in 50 years. *s* nearly constant.
73	81.306	Σ 1300	8 54.6	74 15	P	3	3	1	201.37	5.07	3	
74	80.239	β 409	8 54.9	98 43	H	6	6	2	184.59	9.68	3	
75	80.294	β 104	9 5.3	89 13	H	3	3	1	110.12	2.85	3	
76	80.224	Σ 1329	9 9.6	90 44	H	8	9	2	68.33	22.12	4	*p* has inc. 3° in 50 years. *s* has dec. 5″.5 in 50 years.
76	80.242	Σ 1329	9 9.6	90 44	P	3	3	1	68.53	22.30	3	
77	81.314	Σ 1333	9 11.0	54 8	H	6	6	2	48.78	1.52	2.5	*p* has inc. 10° since 1783. Very little change in *s*.
78	80.209	Σ 1343	9 13.7	84 29	H	7	6	2	271.93	9.88	3	
79	81.339	OΣ 201 AB	9 16.8	61 34	H	6	6	2	232.30	1.35	3	*p* has dec. 4° since 1843.
79	81.339	OΣ 201 AC	9 16.8	61 34	H	6	6	2	309.17	20.49	3	
80	81.299	β 105	9 17.7	63 18	H	6	6	2	204.98	3.00	3	
81	80.260	Σ 1385	9 43.4	72 52	H	9	9	3	353.46	1.08	3	*p* has dec. 8° since 1830. *s* seems nearly constant.
81	80.297	Σ 1385	9 43.4	72 52	P	6	6	2	350.70	1.04	3	

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			R. A.	N. P. D.								
			h. m.	° ′								
82	1880.216	Σ 1389	9 45.5	62 27	H	6	6	2	314.36	2.19	3	*p* has dec. 15° in 50 years. *s* seems to increase slowly.
82	80.216	Σ 1389	9 45.5	62 27	P	6	6	2	314.37	2.29	3	
83	81.311	OΣ 523, 39 Leonis	10 10.6	66 18	H	6	6	2	296.24	6.69	3	*p* probably inc. very slowly. The companion, variable, 10-13 mag.
84	80.320	Σ 1423	10 12.6	68 50	H	7	9	2	68.43	1.27	2.5	*p* has dec. 31° in 50 years. No change in *s*.
84	80.269	Σ 1423	10 12.6	68 50	P		3	1		1.47	2.5	
85	80.237	β 25	10 15.8	99 10	H	6	3	2	180.80	1.85	3	
86	80.697	OΣ 216	10 16.3	74 3	H	7	6	2	142.34	1.64	3	*p* has dec. 22° since 1842. *s* nearly same.
86	80.330	OΣ 216	10 16.3	74 3	P	3	3	1	146.53	1.69	3	
87	81.392	Σ 1428	10 18.4	36 46	H	6	6	2	86.74	3.76	3	*p* has inc. 3° since 1831. *s* has dec. slightly.
88	80.312	OΣ 218	10 21.3	85 50	H	6	6	2	66.91	1.07	3	*p* has inc. 8° since 1848. *s* is prob. inc. very slowly.
89	80.210	δ Antliæ	10 24.1	120 0	H	7	5	2	224.89	10.82	2.5	
90	80.517	Σ 1445	10 26.6	90 15	H	14	12	4	161.98	2.58	3	*p* has dec. 6° in 52 years. *s* changes very little.
90	80.215	Σ 1445	10 26.6	90 15	P	3		1	161.04		3	
91	81.296	Σ 1474 CD	10 41.7	104 38	H	9	9	3	198.01	6.52	3	Change inappreciable in 49 years.
91	81.288	Σ 1474 CD	10 41.7	104 38	P	3	3	1	196.28	7.23	3	
92	80.261	β 595	10 42.8	104 29	H	6	3	2	18.12	1.95	2.5	
93	80.224	Σ 1476	10 43.2	93 23	H	10	6	3	358.70	2.15	2.5	*p* has inc. 6° in 49 years. Very little change in *s*.
93	80.212	Σ 1476	10 43.2	93 23	P	3	3	1	356.28	2.31	2.5	
94	81.283	β 111	10 45.2	98 28	H	3	3	1	6.25	3.51	3	
95	81.308	OΣ 230	10 48.1	68 35	H	6	6	2	14.07	8.17	3	*p* has inc. 9° since 1847. *s* is gradually diminishing.
96	80.248	Σ 1500	10 53.9	92 50	H	10	9	3	316.29	1.43	3	*p* has dec. 8° since 1843. *s* has changed very little.
96	80.243	Σ 1500	10 53.9	92 50	P	6	6	2	317.18	1.56	3	
97	80.238	H_1 77	10 56.2	105 8	H	10	9	3	16.26	3.05	3	*p* has inc. 11° since 1783. No comparison for *s*.
97	80.215	H_1 77	10 56.2	105 8	P	6	6	2	14.80	3.09	3	
98	80.330	β 220	11 6.6	107 51	H	4	3	1	151.07	0.68	3	
99	80.330	Anonymous	11 8.2	104 47	H	1	est	1	8.06		2.5	
100	81.414	Σ 1534	11 15.5	71 9	H	3		1	329.06		2.5	p has dec. 14° since 1827.
101	80.307	Σ 1536 ι Leonis	11 17.6	74 48	H	6	6	2	64.44	2.78	3	*p* has dec. 32° since 1827. *s* changes inappreciably.
101	80.304	Σ 1536 ι Leonis	11 17.6	74 48	P	3	3	1	66.81	2.68	3	
102	80.277	β 340	11 23.8	86 8	H	4	3	2	6.78	3.94	2.5	
103	80.675	Σ 3072	11 24.5	96 3	H	9	9	3	330.32	9.41	3	*p* and *s* have changed very little in 50 years.
103	80.343	Σ 3072	11 24.5	96 3	P	3	3	1	330.01	9.77	3	
104	80.308	Σ 1549	11 26.3	65 0	H	16	12	3	114.37	13.67	2.5	*p* and *s* prob. dec. very slowly.
104	80.341	Σ 1549	11 26.3	65 0	P	3	3	1	114.51	13.64	2.5	
105	80.345	Σ 1566	11 34.4	68 18	H	8	6	2	348.95	2.69	3	No assured change in 50 years.
105	80.345	Σ 1566	11 34.4	68 18	P	7	6	2	349.42	2.87	3	
106	80.486	Σ 1593	11 67.4	91 47	H	5	3	2	23.75	1.49	2.5	*p* has inc. 5° in 50 years. Measures discordant.
106	80.436	Σ 1593	11 67.4	91 47	P	6	6	2	23.50	1.50	2.5	
107	80.330	Anonymous	12 3.0	83 33	H	4	4	1	100.16	6.47	3	
108	80.301	Σ 1604 59 Virg. AB	12 3.2	101 11	H	6	6	2	91.17	11.22	3	*p* has dec. 2° since 1831.
108	80.301	Σ 1604 59 Virg. AC	12 3.2	101 11	H	6	6	2	93.02	42.54	3	*p* has dec. 3° since 1831. *s* has dec. 16″ since 1831.
108	80.310	Σ 1604 59 Virg. AB	12 3.2	101 11	P	3	3	1	91.12	11.68	3	
108	80.310	Σ 1604 59 Virg. AC	12 3.2	101 11	P	3	3	1	92.87	42.70	3	
109	81.466	Σ 1606	12 4.7	49 26	P	3	3	1	157.14	1.13	3	*p* has dec. 11° in 50 years.
110	80.364	β ——	12 9.6	112 41	H	6	6	2	232.38	0.92	3	
111	80.338	Σ 1621	12 9.9	83 42	H	14	9	4	133.16	2.64	3	*p* has inc. 9° in 50 years. *s* is probably dec. slowly.
112	81.370	β 27	12 14.0	75 29	H	3	3	1	102.64	3.09	3	
113	81.455	Σ 1633	12 14.6	62 16	P	3	3	1	247.06	8.58	3	Very little change in 50 years.
113	81.463	Σ 1633	12 14.6	62 16	H	3	3	1	245.47	9.04	3	
114	80.369	Σ 1635	12 15.0	100 48	P	6	6	2	173.17	13.36	4	No decided change in 50 years.
114	81.318	Σ 1635	12 15.0	100 48	H	3	3	1	174.00	13.54	3	
115	81.466	Σ 1641	12 18.7	51 36	P	3	3	1	37.92	8.55	2	*p* has dec. 12° in 49 years. *s* is probably inc. slowly.
115	81.477	Σ 1641	12 18.7	51 36	H	3	3	1	39.36	8.73	3	
116	81.463	Σ 1643	12 21.2	62 18	H	3	3	1	50.70	1.94	3	*p* has dec. 21° in 50 years. No decided change in *s*.
117	80.281	Σ 1644	12 21.3	81 57	H	7	6	2	246.50	20.34	3	It is probable that *p* and *s* both dec. very slowly.
117	80.300	Σ 1644	12 21.3	81 57	P	3	3	1	247.47	21.04	3	
118	80.364	β 28	12 23.9	102 44	P	6	6	2	356.31	2.01	3	

No.	M. Date.	Designations of Stars.	1880.0		O.	p_n	s_n	Ns.	p	s	wt.	Notes.
			R. A.	N. P. D.								
			h. m.	° ′								
119	1880.391	Σ 1659 AB	12 29.5	101 23	H	6	7	2	351.52	27.20	3	Very little change in 50 years
119	80.391	Σ 1659 AC	12 29.5	101 23	H	6	7	2	69.21	34.65	3	*p* and *s* inc., *s* decidedly,
119	80.391	Σ 1659 BC	12 29.5	101 23	H	6	7	2	111.79	39.47	3	*p* dec. and *s* inc., certain.
120	80.317	Σ 1661	12 30.0	77 56	H	7	6	2	234.42	2.39	3	*p* has inc. 8° in 51 years.
120	80.317	Σ 1661	12 30.0	77 56	P	6	6	2	235.50	2.65	3	
121	80.362	Anonymous	12 31.3	97 0	P	3	5	1	76.76	5.89	3	
122	80.368	Σ 1664	12 32.1	100 51	H	6	8	2	249.45	21.08	3	*p* has dec. 23° in 50 years. *s* has inc. 3″ in 50 years.
122	80.349	Σ 1664	12 32.1	100 51	P	6	4	1	247.96	20.80	3	
123	80.320	Σ 1669	12 35.0	102 21	H	12	9	3	304.43	5.75	3	*p* has inc. 6° in 52 years. The change in *s* uncertain.
123	80.349	Σ 1669	12 35.0	102 21	P	4	3	1	306.99	5.94	3	One of the most noted of Binaries. Observed for 160 years. The orbit is completed in about 170 years. Maximum value of *s* about 6″.3. Minimum value of *s* about 0″.4.
124	80.699	Σ 1670 γ Virginis	12 35.6	90 47	H	10	9	3	337.84	5.40	3	
124	80.699	Σ 1670 γ Virginis	12 35.6	90 47	P	9	9	3	338.96	5.24	3	
125	80.865	β 459	12 42.0	85 53	H	7	3	2	293.36	3.79	2	
125	80.360	β 459	12 42.0	85 53	P	3	3	1	291.93	3.20	2	
126	81.321	Σ 1685	12 45.9	70 11	H	3	3	1	201.25	15.78	3	
126	81.321	Σ 1685	12 45.9	70 11	C	3	3	1	200.25	16.20	3	No decided change in 50 years.
126	81.321	Σ 1685	12 45.9	70 11	P	3	3	1	201.23	16.05	3	
127	80.896	Σ 1707	12 55.3	73 29	H	6	6	2	34.59	9.66	3	*p* inc., and *s* dec., slowly.
127	81.321	Σ 1707	12 55.3	73 29	P	3	3	1	34.25	9.43	3	
128	80.343	Σ 1608	12 5.5	35 55	H	5	3	1	223.34	11.42	3	
128	81.466	Σ 1608	12 5.5	35 55	P	3	3	1	222.22	11.78	3	*p* prob. dec, and *s* inc., slowly.
129	80.425	OΣ 256	12 50.3	90 18	H	6	6	2	248.38	0.66	3	*p* has inc. 12° since 1848.
129	80.423	OΣ 256	12 50.3	90 18	P	3	3	1	249.26	0.74	3	
130	80.420	Σ 1711	12 56.5	75 53	H	3	3	1	348.54	1.16	2	*p* has dec. 7° in 51 years. *s* may be decreasing.
131	80.425	Σ 1722	13 2.5	73 52	H	6	6	2	337.63	3.17	3	*p* has dec 6° in 50 years. *s* has probably decreased.
131	80.425	Σ 1722	13 2.5	73 52	P	6	6	2	337.50	3.35	3	
132	80.431	Σ 1742	13 18.0	87 58	H	3	3	1	347.85	1.28	3	*p* probably dec. very slowly.
132	81.398	Σ 1742	13 18.0	87 58	P	3	3	1	350.37	1.55	3	
133	80.376	Σ 1746	13 22.2	79 55	P	4	5	1	250.97	27.81	3	*p* changes very little. *s* dec. slightly.
133	80.878	Σ 1746	13 22.2	79 55	H	6	6	2	249.30	27.34	3	
134	80.372	Σ 1757	13 28.2	89 42	P	7	7	2	66.70	2.30	3	*p* has inc. 56° in 55 years. *s* has inc. slightly.
134	80.387	Σ 1757	13 28.2	89 42	H	4	3	1	69.16	2.19	3	
135	80.390	Σ 1763	13 31.3	97 16	P	6	6	2	44.17	2.42	3	*p* has inc. 5° in 50 years. *s* changes little.
135	82.449	Σ 1763	13 31.3	97 16	H	6	6	2	43.33	2.66	3	
136	81.525	Sm. 488, H_2 3341	13 32.3	61 4	H	6	6	2	191.79	1.89	3	*p* discordant.
137	80.887	Σ 3081	13 38.8	101 12	P	6	6	2	71.50	2.09	3	*p* dec. 6° in 50 years.
137	80.499	Σ 3081	13 38.8	101 12	H	3	3	1	70.14	2.06	3	
138	81.512	OΣ 270	13 41.6	71 57	H	6	6	2	351.94	8.72	3	*p* inc. 6° since 1825. *s* dec. 9″.5 since 1825.
139	80.379	Σ 1788	13 48.6	97 28	H	4	3	1	72.28	2.76	3	p inc. 21° in 55 years.
139	80.390	Σ 1788	13 48.6	97 28	P	7	7	2	74.28	2.78	3	
140	80.814	OΣ 273	13 50.3	84 10	H	9	9	3	111.22	0.84	3	*p* inc. 8° since 1843.
141	81.373	Σ 1804	14 2.5	68 14	H	3	3	1	19.25	4.57	2.5	Very little change in 50 years.
141	81.436	Σ 1804	14 2.5	68 14	P	9	9	3	18.21	4.63	3	
142	81.456	Σ 1808	14 4.7	62 50	P	6	6	2	71.08	2.93	3	*p* is prob. inc. very slowly.
142	81.515	Σ 1808	14 4.7	62 50	H	3	3	1	74.86	2.71	3	
143	81.514	OΣ 279	14 8.0	77 26	H	6	6	2	254.44	2.03	3	*p* has inc. 6° since 1846.
144	81.536	Σ 1834	14 15.9	40 56	H	6	6	2	119.70	0.59	3	*p* has inc. 11° in 49 years. *s* is diminishing regularly.
145	81.406	Σ 1837	14 18.2	101 7	P	6	6	2	309.15	1.48	3	*p* has dec. 23° since 1830.
145	81.449	Σ 1837	14 18.2	101 7	H	3	3	1	303.03	1.33	2	
146	80.452	φ Virginis	14 22.0	91 41	H	3	3	1	108.94	4.35	3	*p* is prob. inc. very slowly. *s* probably increases.
146	80.411	φ Virginis	14 22.0	91 41	P	3	3	1	110.11	4.94	1	
147	81.871	Σ 1847	14 22.2	99 40	P	3	3	1	258.34	23.38	2	*p* has inc. 10° in 50 years. *s* has inc. 5″ in 50 years.
148	81.538	OΣ 284	14 36.1	40 45	H	6	6	2	103.72	6.91	3.5	*p* slowly decreases.
149	81.411	54 Hydræ	14 39.1	114 56	P	3	3	1	130.67	8.90	3	The measures are not decisive.
149	81.496	54 Hydræ	14 39.1	114 56	H	3	3	1	130.38	9.03	3	
150	84.523	Σ 1877 ε Bootis	14 39.8	62 25	H	9	9	3	327.17	2.71	3	*p* inc. very slowly and irreg. The mag. very unequal; colors contrasted. A beautiful object.
151	80.472	Σ 1876	14 40.0	96 53	H	7	6	2	66.94	1.29	2.5	*p* has inc. 15° in 48 years.

No.	M. Date.	Designations of Stars.	1880.0 R. A.	1880.0 N. P. D.	O.	p_n	s_n	Ns.	p	s	wt.	Notes.
			h. m.	° ′								
151	1880.513	Σ 1876	14 40.0	96 53	P	3	3	1	65.38	1.31	3	
152	84.523	Σ 1877 ξ Bootis	14 45.8	70 24	H	10	8	3	267.57	3.59	3	A beautiful Binary. Since 1830 p has dec. 63°. s has dec. 3″.5. Colors contrasted.
153	81.499	So. 190	14 50.5	110 52	H	3	3	1	290.75	15.46	3	p has inc. 20°, and s 5″ since 1823.
154	81.373	OΣ 289	14 50.9	57 14	H	3	3	1	114.45	4.48	3	p dec. 4° since 1846. s nearly constant.
154	81.455	OΣ 289	14 50.9	57 14	P	3	3	1	118.48	4.42	3	
155	81.373	Σ 1901	14 56	58 9	H	3	3	1	199.67	27.02	3	p dec. 4° in 49 years. s dec. 3″ in 49 years.
156	81.520	Σ 1909 ι Bootis	14 59.9	41 52	H	6	6	2	243.65	4.69	3	A beautiful Binary. A miniature of Castor. Since 1819 p has inc. 22°, and s 3″.6. The observations perplexing.
156	81.520	Σ 1909 ι Bootis	14 59.9	41 52	P	6	3	2	241.29	4.77	3	
157	81.466	Σ 1925	15 10.5	97 50	P	3	3	1	8.93	4.74	3	p has inc. 5° in 48 years. s nearly constant.
157	81.466	Σ 1925	15 10.5	97 50	H	6	6	2	11.87	4.71	3	
158	84.540	Σ 1937 η Coronæ	15 18.2	59 17	H	7	5	2	161.67	0.67	3	This remarkable Binary has completed more than 2 revolutions since 1781. The prob. period is 43 or 44 yrs. s varies between 0″.36 and 1″.09.
159	81.537	Σ 1945 AB	15 22.3	74 53	P	3	3	1	286.64	31.91	3	
159	81.546	Σ 1945 AB	15 22.3	74 53	H	6	6	2	286.14	31.58	3	p has inc. 13° in 49 years. s inc. very slowly.
159	81.537	Σ 1945 CB	15 22.3	74 53	P	3	3	1	279.70	9.11	3	Very little change in 49 years.
159	81.546	Σ 1945 CB	15 22.3	74 53	H	6	6	2	280.48	8.62	3	
160	81.513	Σ 1954 δ Scorpii	15 29.1	79 3	P	3	3	1	191.11	3.29	3	p has dec. 11° since 1820. s changes very little.
160	81.514	Σ 1954 δ Scorpii	15 29.1	79 3	H	6	6	2	191.62	3.31	3	
161	81.543	OΣ 297	15 29.7	64 35	H	6	3	2	142.38	7.88	2	p dec. slowly. s dec. 5″.5 in 35 years.
162	80.515	Σ 3095	15 36.3	104 48	H	6	6	2	339.15	2.86	3	p dec. 10° in 50 years. s very nearly constant.
162	80.513	Σ 3095	15 36.3	104 48	P	3	3	1	339.75	2.88	3	
163	81.523	D.M. 36°—2640	15 40.2	54 1	H	3	3	1	45.12	3.94	3	
164	80.524	Σ 1985	15 49.7	91 48	P	4	4	1	333.14	5.88	3	p inc. 6°.5 in 49 years. s nearly constant.
164	80.543	Σ 1985	15 49.7	91 48	H	7	6	2	334.70	5.74	3	
165	81.496	Σ 1993	15 54.4	72 17	H	3	3	1	38.87	30.27	3	s dec. 6″.6 since 1784. p nearly constant.
166	80.875	Σ 1998 ξ Scor. AB	15 57.8	101 2	H	11	9	3	189.58	1.10	3	A fine Binary. Time of revolution about 100 years. s at maximum about 1″.3, at minimum about 0″.4.
166	80.513	Σ 1998 ξ Scor. AB	15 57.8	101 2	P	3	3	1	187.31	1.32	2.5	
166	80.535	Σ 1998 $\frac{AB}{2}$ and C	15 57.8	101 2	H	6	6	2	65.31	7.07	3	p has dec. 23° since 1782. s fluctuates slightly.
166	80.513	Σ 1998 $\frac{AB}{2}$ and C	15 57.8	101 2	P	3	3	1	65.12	7.41	3	
166	84.540	Σ 1998 AB	15 57.8	101 2	H	3	2	1	195.56	1.41	3	
166	84.545	$\frac{AB}{2}$ and C	15 57.8	101 2	H	3	2	1	65.45	7.20	3	
167	81.496	Σ 2007	16 0.4	76 21	H	3	3	1	326.14	33.63	3	p dec. slowly. s inc. 2″ in 50 years.
168	80.540	ν Scorpii AB	16 5.0	109 9	P	8	6	2	361.37	0.56	3.5	A quadruple star, and a beautiful system. It is probable that p and s are increasing. B. discovered by B in 1874.
168	80.549	ν Scorpii AB	16 5.0	109 9	H	7	6	2	360.45	0.51	3.5	
168	80.524	$\frac{AB}{2}$ and $\frac{CD}{2}$	16 5.0	109 9	P	4	4	1	337.23	40.95	3	Very little change in p or s.
168	80.541	$\frac{AB}{2}$ and $\frac{CD}{2}$	16 5.0	109 9	H	4	4	1	336.31	40.83	3	
168	80.524	CD	16 5.0	109 9	P	4	4	1	48.94	2.23	3	p has inc. 9° since 1846. s seems to increase slowly.
168	80.541	CD	16 5.0	109 9	H	4	4	1	48.46	1.96	3	
169	80.538	Σ 2017	16 6.6	75 8	H	4	4	1	251.91	25.82	3	p slowly increase.
170	81.481	Σ 2021	16 7.7	76 9	H	6	6	2	331.96	3.85	3	p has inc. 41° since 1783. s nearly constant.
171	81.548	Σ 2022	16 7.8	63 2	H	3	3	1	136.61	2.29	2	p inc. 7° in 50 years.
172	81.516	Σ 2023	16 8.6	84 10	H	6	6	2	231.44	1.72	3	p dec. 5° since 1832. s nearly constant.
173	84.528	Σ 2032 σ Coronæ	16 10.2	55 50	H	6	5	2	204.71	3.74	3	A triple star. B. revolves rapidly round A. p has inc. 156° in 60 yrs. s inc. 1″3.
174	81.508	Σ 2041	16 19.3	88 29	H	6	6	2	5.05	2.58	3	Measures discordant.
175	81.516	Σ 2055 λ Oph.	16 24.9	87 45	H	6	6	2	37.91	1.48	3	Beautiful Binary. p has inc. 43° in 43 years. s inc. very slowly.
175	81.518	Σ 2055 λ Oph.	16 24.9	87 45	P	3	3	1	35.89	1.61	3	
175	84.542	Σ 2055 λ Oph.	16 24.9	87 45	H	9	7	3	37.80	1.58	3	
176	80.556	Σ 3105	16 25.5	96 47	H	6	6	2	52.28	0.65	3	p dec. 9° in 50 years. s prob. increasing.
176	80.570	Σ 3105	16 25.5	96 47	P	3	3	1	48.61	0.62	3	
177	84.549	Σ 2084 ζ Herculis	16 36.8	58 11	H	12	8	4	90.93	1.32	2.5	One of the most rapid of Binaries Time of revo. ab. 34 yrs. s varies from zero to 1″.6. In 1830 and 1865 one star seemed to occult the other.
178	80.556	Σ 3107	16 52.9	85 51	H	7	6	2	100.69	1.33	3	p dec. 12° in 49 years. s nearly constant.
179	84.556	Σ 2120	17 0.0	61 44	H	3	2	1	250.33	5.52	2.5	p dec. 120° in 50 years. s inc. 2″.3 in 50 years.
180	80.540	H_2 6946 36 Oph.	17 8.0	116 25	H	8	8	2	200.71	4.21	2.5	p dec. 28° since 1825. s probably decreases.
180	80.541	H_2 6946 36 Oph.	17 8.0	116 25	P	3	4	1	200.33	4.22	2.5	
181	80.544	Σ 2156	17 17.8	90 43	H	10	9	3	34.75	3.15	2.5	p inc. slowly. s nearly constant.
181	80.549	Σ 2156	17 17.8	90 43	P	3	3	1	32.50	3.35	2.5	
182	80.543	Σ 2171	17 22.7	99 54	P	3	3	1	66.80	1.76	2	p dec. 8° in 50 years. s nearly constant.
182	80.555	Σ 2171	17 22.7	99 54	H	7	6	2	68.62	1.51	2.5	

No.	M. Date.	Designations of Stars.	1880.0		O.	p_n	s_n	Ns.	p	s	wt.	Notes.
			R. A.	N. P. D.								
			h. m.	° ′								
183	1880.588	Σ 2185 AB	17 28.9	83 53	H	6	7	2	4.54	27.40	2.5	p very slight dec. since 1830.
183	80.562	Σ 2185 AB	17 28.9	83 53	P	3	3	1	5.66	27.64	2.5	
184	80.570	Σ 2244	17 51.0	89 53	H	8	6	2	271.90	1.01	2.5	p has dec. 2° since 1830.
184	80.568		17 51.0	89 53	P	3	3	1	270.30	1.26	2.5	
185	80.558	Σ 2253	17 52.9	75 22	H	4	6	2	79.62	16.12	2.5	p changes very little. s probably dec. slightly.
185	80.562	Σ 2253	17 52.9	75 22	P	3	3	1	80.08	16.07	2.5	
186	80.555	So. 699, Σ 2268	17 58.3	64 38	H	6	7	2	212.56	19.52	3	p dec. 5° since 1825. s inc. 1″.0 since 1825.
186	80.562	So. 699, Σ 2268	17 58.3	64 38	P	3	3	1	210.66	19.56	3	
187	84.518	Σ 2272, 70 Oph.	17 59.4	87 28	H	9	8	3	35.89	2.18	3	Splandid B. Period of rev. ab. 90 yrs. s at max. 6″.7, min. 1″.7. Vari. irreg.
188	80.551	Σ 2286	18 4.3	89 29	H	7	6	2	318.25	2.49	2.5	p dec. 5° since 1832. s constant.
188	80.568	Σ 2286	18 4.3	89 29	P	3	3	1	316.32	2.42	3	
189	80.557	Σ 2294	18 8.4	89 52	H	4	est	1	83.63	0.40	3	p dec. 8°.5 since 1831. s dec. 0″.6 since 1831.
190	80.561	Σ 2303	18 13.6	98 3	H	8	6	2	222.08	2.79	2.5	p inc. 6° in 49 years. s varies very little.
190	80.562	Σ 2303	18 13.6	98 3	P	6	6	2	223.02	3.17	2.5	
191	80.634	Σ 2306 A and $\frac{BC}{2}$	18 15.4	105 9	H	9	9	3	220.75	12.06	3	No change since 1832.
191	80.634	Σ 2306 BC	18 15.4	105 9	H	10	9	3	64.20	0.91	3	s is probably increasing slowly.
192	80.573	Σ 2311	18 16.6	78 37	H	3	3	1	161.56	6.49	3	p dec. 9° in 50 years. s dec. 2″ in 50 years.
193	80.557	AC 11	18 18.7	91 39	H	3	est	1	170.78	0.30	3	p dec. 8° since 1854. s nearly constant.
194	80.573	Σ 2322	18 24.1	86 1	H	3	3	1	168.18	20.09	3	p and s probably increase extremely slowly.
194	80.656	Σ 2322	18 24.1	86 1	P	7	6	2	167.98	20.22	3	
194	80.674	Σ 2322	18 24.1	86 1	C	3	3	1	169.00	20.07	3	
195	80.679	Σ 2421	18 51.6	56 22	P	6	6	2	63.86	21.80	3	p dec. 5° in 50 years. s nearly same.
195	80.679	Σ 2421	18 51.6	56 22	C	6	6	2	64.34	22.14	3	
196	80.762	Σ 2452	18 58.1	14 23	P	3	3	1	216.14	5.55	3	p is prob. dec. very slowly.
196	80.762	Σ 2452	18 58.1	14 23	C	3	3	1	218.42	5.78	3	Very little change since 1832.
196	80.762	Σ 2452	18 58.1	14 23	H	3	3	1	217.14	5.46	3	
197	80.670	H_2 5113	19 17.5	119 32	P	9	10	3	170.70	16.64	3	p inc. 48° since 1837. s dec. 8″ since 1837.
197	80.668	H_2 5113	19 17.5	119 32	C	6	3	2	171.62	16.47	3	
198	80.617	Σ 2515	19 19.4	68 48	H	4	3	1	24.02	12.55	3	p inc. 6° in 51 years. s dec. 6″ in 51 years.
198	80.674	Σ 2515	19 19.4	68 48	P	3	3	1	21.86	12.96	3	
198	80.674	Σ 2515	19 19.4	68 48	C	3	3	1	22.58	12.86	3	
199	80.615	Σ 2541	19 30.2	100 42	H	6	6	2	332.03	3.64	2.5	p dec. 11° in 50 years. s inc. very regularly.
199	80.628	Σ 2541	19 30.2	100 42	P	3	3	1	333.22	3.94	2.5	
200	80.615	Σ 2545	19 32.1	100 26	H	6	6	2	320.38	3.56	3.5	p inc. 5° since 1829. s nearly same.
200	80.687	Σ 2545	19 32.1	100 26	P	6	6	2	320.70	3.82	3.5	Vid. notes of Flammarion.
200	80.687	Σ 2545	19 32.1	100 26	C	6	6	2	320.04	3.72	3.5	
201	80.703	Σ 2571	19 35.6	12 00	P	7	6	2	20.24	11.30	3	p dec. 3° in 48 years.
201	80.703	Σ 2571	19 35.6	12 00	C	6	6	2	20.23	11.30	3	
202	80.671	H_2 2904	19 47.1	114 14	P	6	6	2	139.48	19.22	3	p dec. 35° in 50 years. s slowly dec.
202	80.674	H_2 2904	19 47.1	114 14	C	3	3	1	137.33	17.73	3	
203	80.733	Anonymous	19 49.0	20 3	P	8	6	2	264.66	3.21	3	
203	80.733	Anonymous	19 49.0	20 3	C	6	6	2	262.77	3.29	3	
204	80.685	OΣ 532 β Aquilæ	19 49.4	83 53	P	7	8	2	18.68	12.24	3	p dec. 7° since 1839. s slowly increases.
204	80.685	OΣ 532 β Aquilæ	19 49.4	83 53	C	6	6	2	15.68	12.35	3	
205	80.695	Σ 2612	19 55.5	83 24	P	9	9	3	52.25	38.23	3	s inc. 2″ since 1827.
205	80.695	Σ 2612	19 55.5	83 24	C	9	9	3	52.89	38.48	3	
206	80.786	Σ 2649	20 7.6	58 17	H	3	3	1	150.97	24.36	3	p dec. regularly and slowly s dec. quite regularly.
207	80.708	Σ 2646	20 8.0	96 25	P	9	9	3	48.59	22.70	3	p dec. 3° in 50 years. s dec. 2″.6 in 50 years.
207	80.708	Σ 2646	20 8.0	96 25	C	9	9	3	48.37	22.90	3	
208	80.718	π Capricorni, β 60	20 20.5	108 36	P	9	9	3	145.76	3.27	3	Uncertain.
208	80.725	π Capricorni, β 60	20 20.5	108 36	C	6	6	2	145.15	3.35	3	
209	80.711	Σ 2686	20 24.0	80 6	P	6	6	2	279.21	26.74	3	s dec. 1″.0 in 55 years.
209	80.711	Σ 2686	20 24.0	80 6	C	6	6	2	278.14	27.13	3	
210	80.774	Σ 2729, 4 Aquarii	20 45.1	96 50	P	9	6	2	163.60	0.63	2	p inc. 117° since 1836. s prob. increases.
210	80.786	Σ 2729, 4 Aquarii	20 45.1	96 50	H	3	3	1	167.42	0.40	1	
211	80.732	β 368 45 Aquarii	21 1.0	98 43	P	11	10	3	91.28	0.87	2.5	
212	80.821	β 71	21 4.5	80 21	P	4	4	1	274.19	1.94	3	

No.	M. Date.	Designations of Stars.	1880.0 R. A.	1880.0 N. P. D.	O.	p_n	s_n	Ns.	p	s	wt.	Notes.
			h. m.	° ′								
213	1880.720	H_1 — 47	21 5.7	105 31	P	9	9	3	322.71	3.35	3	*p* dec. very slowly. *s* doubtful.
213	80.743	H_1 — 47	21 5.7	105 31	C	6	6	2	322.22	3.25	3	
214	80.707	Σ 2778	21 9.5	91 44	P	6	6	2	271.67	20.24	3	*p* inc. 4° in 52 years. *s* inc. very little.
214	80.707	Σ 2778	21 9.5	91 44	C	6	6	2	270.80	20.12	3	
215	80.738	Σ 2781	21 9.9	98 10	P	9	12	3	171.76	3.46	3	*p* no change in 52 years. *s* very small increase.
215	80.743	Σ 2781	21 9.9	98 10	C	6	6	2	170.55	3.68	3	
216	80.827	β 370	21 28.2	37 47	P	4	3	1	325.60	3.57	3	
216	80.827	β 370	21 28.2	37 47	C	3	3	1	325.44	3.61	3	
217	80.827	β 274	21 36.4	51 4	P	3	3	1	182.42	3.54	3	
218	80.744	Σ 2838	21 48.3	93 52	P	6	6	2	182.21	20.22	3	*p* dec. 2° in 50 years. *s* dec. 1″.5 in 50 years.
218	80.746	Σ 2838	21 48.3	93 52	C	3	3	1	183.53	20.33	3	
219	80.752	Σ 2847	21 51.9	94 4	P	6	6	2	304.86	1.49	3	*p* inc. 11° in 50 years. *s* doubtful.
220	80.744	Σ 2855	21 59.2	92 1	P	9	9	3	298.27	26.71	3	*p* inc. 4° in 55 years. *s* nearly same.
220	80.743	Σ 2855	21 59.2	92 1	C	6	6	3	297.99	27.61	3	
221	80.762	Σ 2860	21 59.4	29 44	P	3	3	1	254.77	6.28	3	*p* inc. 4° in 48 years. *s* inc. 2″.9 in 48 years.
221	80.762	Σ 2860	21 59.4	29 44	C	3	3	1	254.59	6.12	3	
222	80.774	30 Pegasi AB	22 14.4	84 49	H	6	6	2	17.81	5.95	3.5	*p* dec. 14° since 1825. *s* inc. 1″.6 since 1825.
222	80.762	30 Pegasi AB	22 14.4	84 49	P	3	3	1	16.14	6.12	3	
222	80.774	30 Pegasi AC	22 14.4	84 49	H	6	6	2	219.70	9.60	3.5	*p* inc. 9° since 1825. *s* inc. 4.″ since 1825.
222	80.762	30 Pegasi AC	22 14.4	84 49	P	3	3	1	218.92	9.82	3	
223	80.748	H.N.41–53 Aqua.	22 20.0	107 22	P	9	9	3	307.19	7.89	3	*p* inc. 7° since 1826. *s* dec. 2″.3 since 1826.
223	80.751	H.N.41–53 Aqua.	22 20.0	107 22	C	6	6	2	307.58	7.97	3	
224	80.759	Σ 2909 ζ Aqua.	22 22.6	90 38	P	6	6	2	332.07	3.58	3	Fine Binary System. *p* dec. 28° in 58 years. *s* dec. 1″.5 in 58 years. Period, perhaps about 1500 years.
224	80.759	Σ 2909 ζ Aqua.	22 22.6	90 38	C	6	6	2	332.37	3.91	3	
225	80.759	Σ 2928 L.l. 44276	22 33.2	103 14	P	3	3	1	317.15	4.52	3	*p* dec. 10° since 1831. *s* nearly same.
225	80.759	Σ 2928 L.l. 44276	22 33.2	103 14	C	3	3	1	317.28	4.72	3	
225	80.852	Σ 2928 L.l. 44276	22 33.2	103 14	H	3	3	1	316.90	4.23	3	
226	80.808	Σ 2941	22 40.1	71 24	H	3	3	1	264.73	9.84	3	*p* dec. 5°.5 in 50 years. *s* inc. 1″.0 in 50 years.
227	80.762	τ^1 Aquarii	22 41.3	104 41	P	3	3	1	114.53	27 62	3	*p* inc. 5° since 1784. *s* dec. 8″.0 since 1784.
227	80.762	τ^1 Aquarii	22 41.3	104 41	C	3	3	1	115.80	27.86	3	
227	80.808	τ^1 Aquarii	22 41.3	104 41	H	3	3	1	114.44	27.91	3	
228	80.787	Σ 2944 AB	22 41.6	94 51	H	6	6	2	253.17	3.33	4	*p* inc. 6° since 1833. *s* dec. nearly 1″.
228	80.808	Σ 2944 AB	22 41.6	94 51	P	3	3	1	253.26	3.38	3	
228	80.787	$\frac{AB}{2}$ and C	22 41.6	94 51	H	3		1	136.80		2	*p* dec. 22° since 1829.
229	80.716	OΣ 481	22 42.0	12 7	P	4	3	1	268.98	2.04	3	*p* prob. increases slowly.
230	81.773	Σ 2959	22 50.7	93 53	P	9	9	3	100.73	14.28	3	*p* inc. 4° since 1832. *s* dec. 1″.5 since 1832.
230	81.804	Σ 2959	22 50.7	93 53	C	3	3	1	100.87	14.08	3	
231	81.214	Σ 2998, 94 Aqua.	23 12.8	104 7	P	11	12	3	346.17	13.68	3	p inc. 4° since 1802. *s* nearly constant.
231	81.214	Σ 2998, 94 Aqua.	23 12.8	104 7	C	10	10	3	346.21	13.70	3	
232	80.808	Σ 3008	23 17.5	99 7	H	4	4	1	255.82	4.65	3	*p* dec. 19° since 1824. *s* dec. 3″.0 since 1824.
232	81.187	Σ 3008	23 17.5	99 7	P	11	11	3	254.00	5.00	3	
232	80.920	Σ 3008	23 17.5	99 7	C	7	7	2	253.76	4.94	3	
233	81.831	78 Pegasi (A. C.)	23 36.0	61 25	P	14	9	3	186.71	1.65	3	
234	80.808	So. 356 ι^2 Aqua.	23 39.8	109 21	H	3	3	1	140.84	5.77	3	*p* dec. 3° in 59 years. *s* inc. slightly.
234	81.178	So. 356 ι^2 Aqua.	23 39.8	109 21	P	10	6	3	140.84	5.53	3	
234	81.804	So. 356 ι^2 Aqua.	23 39.8	109 21	C	3	3	1	138.90	6.12	3	
235	81.772	Σ 3049 σ Cassiop.	23 50.1	35 12	P	6	6	2	326.65	3.06	3	*p* prob. inc. slowly. *s* nearly constant.
235	81.772	Σ 3049 σ Cassiop.	23 50.1	35 12	C	6	6	2	327.42	3.27	3	
236	81.000	Σ 3046	23 50.2	100 10	H	3	3	1	246.27	2.70	2.5	*p* inc. 13° in 50 years. *s* prob. inc. slowly.
237	81.817	Σ 3046	23 50.2	100 10	P	6	6	2	243.25	3.48	3	
238	81.802	Σ 3050	23 53.4	56 56	P	6	7	2	201.67	3.28	3	*p* inc. 10° since 1832. *s* prob. dec. very slowly.
238	81.801	Σ 3050	23 53.4	56 56	C	3	3	1	204.08	3.11	2.5	

During several years of my earlier work in this Observatory, numerous intervals of time between other observations were employed in measuring a few double stars promiscuously taken. I did this, rather to gain experience and facility in determining angles and distances with a filar micrometer, than to furnish authoritative measures for the stars themselves. I also wished to gain some practical idea of the precision which I might expect to attain in such work, compared with that of observers of acknowledged repute. Of course many of the earlier measures were defective; and some have been entirely rejected. While only a few stars appear in this list, and most of them well known, yet in these odd intervals of time more than eighteen hundred independent measures were made, and the casual practice thus afforded gave some facility, and a reasonable accuracy in this field of astronomical work.

On a careful comparison of my measures with those of trained double-star observers, who may, perhaps, be called standard observers, I find in them a prevailing peculiarity, which is no doubt the index of "Personal Equation." I may thus state, in a general form, the result of my comparisons. My habit, or tendency, is to measure distances too large. Very seldom do I measure a distance too small. My tendency is also to measure position-angles too large; yet I much more frequently measure them too small than I do distances. This general statement applies specially to the distances and angles for close pairs of stars. For distances greater than $5''$ or $6''$ this "personal tendency" seems almost to disappear; and I find no systematic discrepancies for such distances between my own measures and those of skilled observers.

The following scale will afford a tolerably correct approximation to my personal difference for varying distances. Writing $\triangle$ for the mean of the distances of any pair of stars as determined by standard observers, and π for the position angle, also s and p for the same general quantities, as resulting from my own observations; then —

For distances between $0''$ and $2''$, $\triangle - s$ varies between zero and $-.3''$, and $\pi - p$, between zero and $\mp 5°$.
" " $2''$ and $4''$, $\triangle - s$ " " " $-.4''$, and $\pi - p$, " " $\mp 3°$.
" " $4''$ and $6''$, $\triangle - s$ " " " $-.2''$, and $\pi - p$, " " $\mp 1°$.

In these equations I have written the negative sign invariably in the right hand member for distances; but the double sign in the right hand member for angles. This is done, because I seldom measure a distance too small, while for separate stars, angles are measured too small about one time in four. In making these comparisons I have consulted not only the Manuals of Flammarion, and of Crossley, Gledhill & Wilson, but also the work of the Struves, Hall, Dembowski, Stone and Burnham, as well as the various series published of late years in the

Astronomische Nachrichten, by Schiaparelli, Engelmann and others. I mean to say that these equations will approximate to the average result of my measures. As in all averages, there are extremes on either side.

MEAN RESULTS OF DOUBLE-STAR MEASURES.

No.	M. Date.	Designation of Star.	1880.0		p	s_n	N_n	p	s	wt.	Notes.
			R. A.	N. P. D.							
			h. m.	° ′				° ′.	″		
1	1876.861	Σ 8, 27 Ceti	0 5.4	93 45	5	4	1	294.20	7.07	3	Very little change in last 50 years.
2	76.859	Σ 46, 55 Piscium	0 33.6	69 13	6	3	1	190.00	6.32	3	Very little change in last 50 years.
3	76.946	Σ 180, γ Arietis	1 46.9	71 18	4	4	1	360.00	8.78	3	Small change in *p* and *s* in last 50 years.
4	76.930	Σ 202, α Piscium	1 55.8	87 49	6	5	1	322.70	3.05	3	Slowly changing in *s* and *p*.
5	76.790	Σ 205, γ Andro.	1 56.5	48 15	14	10	3	63.40	10.46	3	A and $\frac{BC}{2}$ One night by H.S.P.
6	77.891	Σ 299, γ Ceti	2 37.5	87 14	8	8	1	291.00	3.10	3	*p* is prob. inc. very slowly.
7	79.103	Σ 334	2 53.0	83 50	2	4	1	316.80	1.84	4	Very little change in 50 years.
8	76.853	Σ [118], ϕ Tauri	4 13.0	62 56	6	2	1	127.25	55.09	3	
9	79.104	Σ 688	5 13.7	100 52	8	8	2	274.95	10.49	4	No certain change.
10	77.076	Σ 774, ζ Orionis	5 34.7	92 0	5	5	1	154.20	2.70	3	A and B. The angle increasing slowly.
11	76.951	Σ 716, 118 Tauri	5 21.9	64 57	7	6	1	200.20	4.87	3	C. W. P., Jr. One night.
12	78.159	Sirius	6 39.7	106 32		6			11.140	5	Clark companion.
	.172	Sirius	6 39.7	106 32	6	2		55.55	11.341	2	
	.175	Sirius	6 39.7	106 32	7	6		54.84	11.344	3	
	.192	Sirius	6 39.7	106 32	13	6		53.87	11.353	3	
	.230	Sirius	6 39.7	106 32	6			54.10		4	
	.235	Sirius	6 39.7	106 32	8	8		54.32	11.180	5	
Mean	78.193							54.45	11.243	3.6	
13	1878.192	Sirius	6 39.7	106 32	3			158.16		3	Lassell companion, or Goldschmidt companion.
	.200	Sirius	6 39.7	106 32	4	4		159.30	102.93	4	
	.203	Sirius	6 39.7	106 32	5	4		157.95	103.47	4	
	.219	Sirius	6 39.7	106 32	2	2		158.95	107.90	3	
	.236	Sirius	6 39.7	106 32	6	5		157.69	102.96	5	
Mean	78.210							158.39	103.45	3.8	
14	1878.194	Sirius	6 39.7	106 32	4	1		115.06	66.32	1	Marth companion.
	.197	Sirius	6 39.7	106 32	2	3		114.95	67.13	2	
	.203	Sirius	6 39.7	106 32	3			113.90		2	
	.223	Sirius	6 39.7	106 32	3	2		113.58	68.01	3	
	.246	Sirius	6 39.7	106 32		4			70.67	5	
Mean	78.213							114.36	68.99	2.6	
15	1879.267	Sirius	6 39.9	106 32		4			10.44	3	Clark companion.
	.193	Sirius	6 39.9	106 32	5	5		49.15	10.42	4	
	.179	Sirius	6 39.9	106 32	2			52.09		3	
	.103	Sirius	6 39.9	106 32	2	4		50.34	10.80	4	
	.099	Sirius	6 39.9	106 32	3	3		51.94	11.04	4	
	.086	Sirius	6 39.9	106 32	2	2		48.25	11.21	4	
Mean	79.155							50.35	10.78	3.6	
16	1877.073	Σ 982, e Gemin.	6 47.3	76 40	4	5	1	161.90	6.35	4	Angle slowly decreasing.
17	76.964	Σ 1110, α Gemin.	7 26.9	57 58	11	7	3	236.80	5.61	3	Angle decreases. Binary.
18	77.304	Σ 1196, ζ Cancri	8 5.3	71 59	12	6	2	131.00	5.33	4	Angle dec. $\frac{AB}{2}$ and C.
19	77.324	Σ 1196, ζ Cancri	8 5.3	71 59	14	9	2	107.30	0.74	4	A and B. Angle decreases.
20	79.146	Σ 1295, 17 Hydræ	8 49.6	97 31	8	8	2	357.60	4.36	4	Very little change in 50 years.

No	M. Date.	Designation of Star.	1880.0		p_n	s_n	N_n	p	s	wt.	Notes.
			R. A.	N. P. D.							
			h. m.	° '				° '	''		
21	1878.228	Σ 1424, γ Leonis	10 13.4	69 33	24	17	6	113.20	3.70	3	Angle inc. slowly, and dist. variable.
22	77.333	Σ 1523, ξ U.Maj.	11 11.8	57 47	6	7	1	291.50	1.35	4	Binary. Period about 60 yrs.
23	78.546	Σ 1530	11 13.6	96 15	15	8	5	310.70	7.78	4	Very little change in 50 yrs.
24	79.006	Σ 1670, γ Vir.	12 35.6	90 47	21	21	5	336.33	5.07	4	Rapid Binary. Period 150 yrs.
25	79.445	Σ 1692, 12 C.V.	12 50.4	51 2	3	3	1	228.61	19.88	5	Little change in 50 years.
26	79.397	Σ 1742	13 18.0	87 58	8	8	3	349.83	1.45	3	Very little change in 50 yrs.
27	79.562	Σ 1777, o Vir.	13 37.0	85 51	8	6	2	227.68	3.59	4	The angle dec. slowly.
28	79.421	Near OΣ 273			9	9	3	337.97	1.29	4	This star was meas. for OΣ 273. Prob. a slip of Dec. Vernier.
29	78.347	Σ 1877, ε Bootis	14 39.7	62 25	27	27	5	326.80	2.90	4	Yellow and green. Angle inc. slowly.
30	79.161	Σ 1873	14 38.9	81 47	12	12	4	94.01	6.83	4	Very little change in 50 yrs.
31	79.562	Σ 1888, ξ Bootis	14 45.8	70 24	8	8	2	278.30	4.35	4	Angle and distance both decreasing.
32	79.592	Σ 1909, 44 Bootis	14 59.8	41 52	8	8	2	238.20	4.88	4	Binary. Angle inc. slowly.
33	78.804	Σ 1937, η Cor.	15 18.2	59 17	31	26	6	84.43	0.87	3	Rapid Binary. Period 43 yrs.
34	79.579	Σ 1954, δ Ser.	15 29.1	79 3	8	8	2	189.04	3.56	4	Angle decreases.
35	79.397	Σ 1962, 178 Lib.	15 32.2	98 24	9	10	2	187.38	11.77	4	Almost no change in 50 yrs.
36	76.453	Σ 1965, ζ Cor.	15 36.3	52 59	4	2	1	299.90	6.30	3	H. S. P. Very small change in 100 years.
37	78.798	Σ 1998, ξ Scor.	15 57.8	101 2	19	16	4	68.25	7.48	4	$\frac{AB}{2}$ and C. H.S.P. one night.
38	76.453	Σ 1998, ξ Scor.	15 57.8	101 2	3	2	1	147.47	43.20	3	H.S.P. $\frac{AB}{2}$ and D.
39	79.583	Σ 1998, ξ Scor.	15 57.8	101 2	8	8	2	185.65	1.47	3	A. B. Fine double double.
40	79.504	β Scorpii	15 58.5	109 29	5	5	2	24.17	13.51	4	A. and C.
41	79.581	11 Scorpii, β 39	16 1.0	102 26	7	9	2	256.50	3.31	4	
42	79.536	ν Scorpii	16 5.0	109 9	9	8	3	336.80	40.95	4	Double double, $\frac{AB}{2}$ and C,
43	79.549	ν Scorpii	16 5.0	109 9	7	4	2	45.40	2.00	4	C. and D.
44	78.879	Σ 2032, σ Cor.	16 10.2	55 50	12	15	3	202.00	3.74	4	A. and B. Angle and distance increase.
45	79.624	Σ 2032, σ Cor.	16 10.2	55 50	2	2	1	87.25	55.52	3	A. and D.
46	79.661	Σ 2021, 49 Ser.	16 7.7	76 9	3	3	1	331.63	3.78	4	Angle increasing, distance variable.
47	78.937	Antares	16 22.0	116 10	17	23	6	270.93	3.11	4	Little change since 1846.
48	78.567	Σ 2055, λ Oph.	16 24.9	87 45	10	10	4	33.12	1.60	4	Rapid Binary.
49	77.623	Σ 2010, κ Her.	16 2.6	72 38	6	5	1	9.33	29.96	4	Angle and distance change slowly.
50	77.568	Σ 2084, ζ Her.	16 36.8	58 11	5	5	1	141.20	1.60	3	Very rapid Binary. Period 33 years.
	79.670	Σ 2084, ζ Her.	16 36.8	58 11	12	12	3	124.93	1.56	4	
51	79.675	Σ 2130, μ Dra.	17 2.9	35 22	3	3	1	166.63	2.70	4	Angle and Dist. dec. Retrograde Binary.
52	78.489	Σ 2140, α Her.	17 9.1	75 28	18	18	4	115.26	4.73	4	Very little change in 100 yrs. Fine contrast of colors. R.& G.
53	77.605	Σ 2161, ρ Her.	17 19.5	52 44	11	13	2	311.41	3.89	4	Distance probably increases.
54	78.564	Σ 2168	17 29.7	88 55	14	11	3	80.71	2.87	4	Little change.
55	78.724	Σ 2244	17 50.9	89 55	7	3	2	276.25	1.15	3	Little change.
56	78.967	Σ 2262, τ Oph.	17 56.5	98 11	14	13	3	250.39	1.73	3	Angle increases. *s.* variable.
57	78.590	Σ 2272, 70 Oph.	17 59.4	87 28	17	17	4	75.52	3.20	4	Splendid Binary. Period 80 years.
58	78.703	Σ 2382, ε_1 Lyræ	18 40.4	50 27	9	8	2	16.60	3.16	4	Angle changes.
59	79.685	Σ 2383, ε_2 Lyræ	18 40.4	50 27	6	6	2	139.61	2.53	4	Angle changes.
60	76.888	Σ 37 App I, $\varepsilon_1\varepsilon_2$ Ly	18 40.4	50 27	5	2	1	172.90	207.02	4	
61	79.595	Σ 2513	19 19.1	87 47	10	8	2	318.41	2.45	3	Small change in angles.
62	78.486	Σ 2519	19 21.6	99 47	7	4	1	123.42	11.40	4	Little change.
63	78.669	Σ 2621	19 58.8	81 6	7	4	2	222.77	5.93	4	Very small change.
64	79.648	π Capric., β 60	20 20.4	108 36	4	6	2	146.10	3.41	4	
65	79.569	ρ Capric., β 61	20 22.0	108 13	7	6	2	174.33	2.96	4	
66	79.702	Σ 2735	20 49.4	85 55	3	3	1	285.39	2.30	4	Very little change.
67	79.687	Σ 2737, ε Equ.	20 53.1	86 10	6	6	2	75.15	10.90	4	$\frac{AB}{2}$ and C. Changes very small.
68	79.687	Σ 2737, ε Equ.	20 53.1	86 10	6	6	2	288.66	1.09	4	A. and B. Changes very small.
69	78.664	Σ 2742	20 56.3	83 18	13	12	3	220.95	2.67	4	Changes very doubtful.
70	79.715	Σ 2749	20 58.7	86 57	6	7	2	155.51	3.57	4	Angle slowly inc. A. and $\frac{BC}{2}$
71.	79.721	Σ 2749	20 58.7	86 57	3	3	1	148.14	1.22	4	B. and C. *p* and *s* inc. slowly.
72	76.792	Σ 2727, γ Delph.	20 41.8	71 18	6	4	1	273.40	10.91	4	*p* and *s* decrease slowly.
73	78.638	Σ 2781	21 10.3	98 9	4	6	2	167.50	3.54	3	Angle probably decreases.
74	78.622	Σ 2848	21 52.0	84 38	18	15	3	55.32	11.00	4	Change very doubtful.
75	77.686	Σ 2909, ζ Aqua.	22 22.6	90 38	8	8	2	333.14	3.74	4	Angle decreases.

METEOROLOGICAL OBSERVATIONS.

Explanations of the Record. The meteorological observations made at MORRISON OBSERVATORY are primarily for Observatory use, especially those of temperatures and pressures. But as the record of these observations may be of some use in studying the laws and vicissitudes of climate in central Missouri, a monthly synopsis of results is now published. Beginning with Oct. 1, 1877, it includes the eight years ending with Oct. 1, 1885.

The observations are made three times during the civil day of twenty-four hours. They consist in reading the attached and external thermometers, reading the barometer, estimating the degree of cloudiness, noting the direction and relative velocity of the wind, and noting such other special phenomena as are considered important or interesting. The times of reading and estimation are at or near 7^h, 12^h, 19^h; reckoning the hours from zero at midnight up to 24. The degree of cloudiness is reckoned in units up to 10, which denotes entirely overcast. The monthly per cent. of cloudiness shown in the following tables is really not a proper estimate of the relative prevalence of clouds and clear skies, but only the estimated relation of the two for the hours of reading. Could we have a correct picture of the vaulted dome above and around us, showing the absolute ratio of cloud prevalence to clear sky during every half hour of the day, I am very sure the per cent. of cloudiness would be 10 or 15 per cent. higher than that determined by the three daily estimates. As no anemometer has been kept, only the relative velocity of winds prevalent since last reading is given. All winds are compared, as far as practicable, with a light breeze as a unit. In the absence of absolute determination of wind motion, this comparison may have its use for general purposes. The scale of comparison runs from 1 to 10. At ten we reach the limit of our strongest winds short of violent storms, hurricanes and tornadoes, which are noted as special phenomena. The direction of winds is given for the nearest octant. Under each octant is recorded the number of times each month the wind blew from that direction, and its mean monthly relative velocity. The monthly means of the actual readings of the barometer and thermometers are given for 7^h, 12^h, 19^h, B standing for barometer, T_a the thermometer attached to the barometer tube, and T_e the external thermometer. For description and exposure of these instruments, see the introduction. The barometer cistern stands 750 feet above sea level, and no reductions have been applied. As no self-registering instruments have been in use, the given maxima and minima are those obtained by special watching at or near extremes of temperature and pressure.

DIRECTION AND COMPARATIVE VELOCITY OF WINDS.

Dates.	E.		N.E.		N.		N.W.		W.		S.W.		S.		S.E.	
	Dir.	R. V.	Dir.	R. V.	Dir.	R. V.	Dir.	R. V.	Dir.	R. V.	Dir.	R. V.	Dir.	R. V.	Dir.	R.V
1878, October	11	2.7	6	3.0	10	2.2	10	3.8	23	2.0	12	4.7	13	2.5	8	3.1
November	14	2.7	12	3.4	1	2.0	21	2.5	22	2.4	6	1.6	5	2.0	9	3.0
December	5	2.5	5	3.1	3	1.0	25	2.5	36	2.6	9	2.1	4	1.5	6	1.9
1879, January	8	2.6	4	3.2	2	1.0	17	3.3	29	2.6	14	3.4	4	2.5	10	2.9
February	3	3.0	1	3.0	13	3.0	21	3.9	13	2.7	10	3.0	8	3.5	14	3.2
March	12	2.9	9	3.6	6	2.5	21	3.9	3	4.0	9	4.0	9	3.8	11	3.3
April	10	1.8	11	1.8	11	1.2	11	2.6	9	2.1	4	1.2	4	1.0	20	1.9
May	19	2.1	8	1.9	5	2.8	4	2.5	14	1.7	8	3.1	14	3.3	16	3.0
June	17	2.3	3	1.0	4	1.5	8	2.5	15	2.0	4	2.0	10	2.6	24	2.6
July	22	1.5	7	1.3	3	0.3	8	2.2	12	1.8	8	2.2	17	2.2	9	1.1
August	13	2.0	10	2.2	5	2.6	11	2.4	8	2.6	13	2.7	19	2.6	9	1.9
September	15	1.8	10	2.6	2	3.0	13	3.0	11	2.8	4	3.7	8	3.3	20	3.2
1879, October	10	1.9	8	1.1	1	3.0	13	2.7	10	1.8	4	1.6	14	1.6	29	2.4
November	12	1.9	6	2.1	2	2.5	14	3.3	14	2.4	6	2.7	9	2.0	22	2.4
December	18	1.9	4	1.8	3	2.6	19	2.1	18	2.5	4	3.5	7	2.7	20	2.0
1880, January	11	2.3	4	2.2	6	2.1	18	3.2	17	2.4	11	1.4	14	2.3	12	2.6
February	11	2.0	2	2.5	7	2.0	18	2.4	17	2.9	8	3.5	10	3.4	14	3.2
March	18	2.3	6	3.0	4	2.8	23	2.2	16	2.4	5	3.4	7	3.6	13	3.3
April	6	2.8	7	2.1	6	2.2	19	3.0	20	3.0	8	3.6	12	3.8	13	2.8
May	19	2.3	6	1.7	4	1.5	6	1.8	11	2.5	8	2.9	15	2.2	25	2.5
June	24	2.2	6	1.8	1	1.0	6	2.6	14	2.7	3	3.3	20	2.6	17	2.6
July	10	2.0	6	0.8	4	1.2	16	2.2	21	1.9	12	2.7	11	2.4	12	2.2
August	21	1.4	4	2.5	1	1.0	11	1.5	12	0.7	6	2.3	11	1.6	22	1.6
September	14	2.0	6	1.3	5	1.2	19	2.4	17	1.7	4	2.7	15	2.3	10	2.7
1880, October	17	2.3	5	1.6	3	2.3	20	2.9	15	2.6	10	3.2	6	3.3	17	2.8
November	8	1.5	5	1.6	1	2.0	28	2.8	25	2.2	7	2.1	4	1.7	14	2.1
December	15	2.9	10	2.5	5	2.4	14	2.9	25	2.1	4	2.1	4	3.0	16	2.1
1881, January	19	2.4	2	3.0	6	2.8	30	2.6	17	2.1	3	1.6	5	2.6	12	2.4
February	19	3.0	4	3.0	1	2.0	19	2.7	15	2.9	7	2.1	2	2.0	16	3.3
March	20	3.1	0	0.0	5	3.2	32	4.0	26	2.6	0	0.0	1	2.0	8	2.7
April	35	2.8	20	2.0	0	0.0	20	3.7	14	2.6	0	0.0	2	2.0	17	3.0
May	35	2.2	2	2.0	1	2.0	9	2.7	10	2.9	4	2.2	0	0.0	31	2.5
June	24	3.1	3	3.6	6	1.5	7	3.4	14	3.6	10	4.3	6	2.6	19	3.0
July	24	2.3	15	2.2	2	2.0	9	2.0	16	2.3	21	2.6	3	1.6	6	1.6
August	27	2.0	20	3.0	4	3.0	2	2.5	14	2.6	7	2.6	5	2.8	17	2.9
September	11	2.1	0	0.0	4	1.2	13	2.5	14	2.9	15	3.9	18	3.0	16	3.5
1881, October	21	2.8	4	3.7	3	1.2	8	2.7	18	2.3	4	2.5	15	2.8	19	2.5
November	9	3.2	2	2.0	0	0.0	21	3.3	29	2.6	1	4.0	11	2.6	9	3.3
December	11	2.3	1	3.0	0	0.0	21	3.0	2	1.9	7	2.8	6	3.0	26	2.0
1882, January	20	3.0	5	2.2	4	3.0	19	2.9	11	2.5	9	2.3	8	2.4	18	2.4
February	6	1.8	9	2.9	5	2.8	4	1.0	22	1.8	11	3.5	6	3.0	21	3.4
March	22	2.6	6	2.5	5	3.0	17	3.0	20	4.0	3	3.0	6	3.1	14	2.4
April	16	3.0	9	4.0	2	1.3	15	2.4	21	3.2	5	3.2	4	4.0	20	3.0
May	2	2.7	10	2.1	3	2.0	14	3.0	16	3.0	2	5.0	3	5.7	25	2.5
June	13	2.5	7	3.0	0	0.0	10	3.1	16	3.2	13	3.6	20	2.9	9	1.9
July	14	2.1	9	1.4	3	2.7	10	2.3	16	2.4	4	2.2	12	2.1	22	2.0
August	12	1.7	12	2.2	4	2.5	19	2.9	13	2.6	1	3.0	10	2.7	22	2.1
September	24	2.2	12	2.5	0	0.0	8	2.2	12	2.8	3	3.3	5	4.2	21	2.7
1882, October	13	2.1	7	2.3	3	1.7	10	2.2	13	1.9	6	2.8	7	3.7	34	2.6
November	11	1.7	5	1.4	2	3.0	21	3.3	18	3.0	8	4.0	4	3.0	13	2.4
December	7	2.4	4	1.2	6	2.3	21	3.4	29	2.6	7	2.4	0	0.0	23	3.0

Dates.	E.		N.E.		N.		N.W.		W.		S.W.		S.		S.E.	
	Dir.	R. V.	Dir.	R. V.	Dir.	R. V.	Dir.	R. V.	Dir.	R. V.	Dir.	R. V.	Dir.	R. V.	Dir.	R.V
1883, January	18	2.5	9	3.3	0	0.0	24	3.6	27	3.0	1	2.0	2	3.0	13	3.2
February	22	2.2	4	2.7	0	0.0	23	2.9	25	2.8	6	2.0	0	0.0	7	2.0
March	15	3.0	24	3.1	5	3.4	23	3.4	13	3.2	13	3.9	0	0.0	2	2.5
April	8	4.0	7	3.6	4	3.5	10	2.4	13	3.4	16	3.6	3	2.0	27	3.1
May	9	2.2	4	2.2	5	2.6	25	3.1	10	2.8	18	4.1	5	2.4	19	3.4
June	11	2.7	5	1.7	1	2.0	18	4.3	25	5.1	6	1.7	4	1.1	18	4.8
July	11	2.3	11	3.0	3	2.7	10	2.8	12	2.1	22	3.8	13	3.3	11	2.1
August	16	1.9	8	1.2	3	1.3	18	2.6	20	1.9	5	3.2	10	2.9	16	2.4
September	17	1.5	16	2.9	5	2.2	16	2.3	7	2.6	13	3.5	6	3.3	10	2.3
1883, October	20	2.6	21	2.6	4	2.0	15	2.0	12	2.4	4	3.5	1	2.0	19	3.0
November	6	1.7	2	4.0	1	1.0	18	3.1	16	2.6	11	2.7	13	3.4	21	2.9
December	6	2.5	2	2.0	2	1.0	25	3.0	19	1.5	12	2.2	4	1.5	20	2.2
1884, January	4	1.5	7	2.0	0	0.0	34	3.0	15	2.3	10	1.8	4	2.0	11	1.6
February	9	1.8	17	2.5	0	0.0	19	3.8	14	3.0	9	3.0	1	2.0	15	2.9
March	22	2.7	22	2.7	1	3.0	22	3.3	8	2.6	9	2.1	4	1.5	19	3.3
April	13	2.0	22	2.6	3	2.6	13	3.7	19	2.2	12	3.3	2	6.0	13	3.0
May	8	1.6	16	3.0	0	0.0	20	2.4	21	2.1	6	2.0	4	2.7	18	2.1
June	16	1.8	11	1.9	3	2.0	8	2.6	11	2.3	2	1.5	4	2.7	35	1.9
July	7	2.4	12	1.8	7	2.1	19	2.3	11	2.1	4	3.0	11	2.5	23	2.4
August	4	2.5	16	2.5	5	1.2	16	2.2	8	2.4	8	2.9	10	2.7	25	2.5
September	4	3.2	10	2.0	3	1.7	8	2.1	3	2.0	6	2.3	27	2.3	31	2.4
1884, October	3	2.6	4	2.0	2	3.0	15	2.5	21	2.3	8	2.7	13	4.3	16	2.4
November	6	2.7	9	3.0	4	2.1	26	2.8	8	3.3	17	2.1	8	1.7	12	2.2
December	13	3.5	8	2.6	2	5.0	21	3.0	21	2.4	1	3.0	2	1.0	25	2.0
1885, January	9	3.0	17	2.5	0	0.0	21	3.6	11	2.0	11	2.1	2	1.5	22	2.4
February	6	3.3	18	2.9	4	2.2	19	3.4	15	3.2	17	2.5	4	1.0	2	2.0
March	11	2.2	18	3.1	0	0.0	28	3.2	10	2.8	17	2.4	4	1.2	6	2.7
April	8	3.0	19	2.0	0	0.0	23	3.0	5	3.0	10	2.0	5	2.0	20	3.0
May	4	3.2	10	2.0	3	3.3	30	2.6	17	2.4	9	2.9	4	2.7	22	2.4
June	16	2.1	19	2.1	2	2.5	8	3.5	6	4.2	6	3.5	16	3.5	22	2.4
July	7	1.9	13	1.8	0	0.0	12	1.5	19	3.0	6	3.5	22	3.0	38	2.0
August	5	2.2	22	0.0	1	1.0	18	2.7	7	1.7	9	3.3	10	3.8	21	1.9
September	3	2.7	27	2.4	3	3.0	15	3.0	6	2.1	8	2.3	8	3.3	23	2.6

MONTHLY MEANS AND EXTREMES OF PRESSURE.

(FOR HEIGHT AND DESCRIPTION OF BAROMETER, SEE THE INTRODUCTION.)

Dates.	PRESSURES.	MAXIMUM PRESSURES.		MINIMUM PRESSURES.		Notes
	Monthly Means.	Date.	Reading.	Date.	Reading.	
1877, October	29.256	10	29.530	19	28.700	For 1877-78, the means are given only for *Mean Noon.* The *Annual Mean* for noon of this year is 29.225 inches. Mean of Maxima, 29.516 inches. Mean of Minima, 28.839 inches.
November	29.267	10	29.650	26	28.842	
December	29.311	13	29.636	4	28.790	
1878, January	29.190	6	29.632	31	28.934	
February	29.162	26	29.612	21	28.590	
March	29.152	18	29.463	27	28.738	
April	29.018	28	29.281	9	28.582	
May	29.228	9	29.480	6	28.870	
June	29.240	5	29.460	2	28.950	The low Barometer, June, 1, corresponds to the great Tornado at Richmond, Mo.
July	29.287	2	29.412	25	28.954	
August	29.255	16	29.376	20	29.124	
September	29.336	26	29.660	28	28.988	

MONTHLY MEANS AND EXTREMES OF PRESSURES.

Dates.	General Means.			Maxima.		Minima.		Notes.
	Morning.	Noon.	Evening.	Date.	Reading.	Date.	Reading.	
1878, October	29.310	29.268	29.253	26	29.730	15	28.850	
November	29.292	29.298	29.243	2	29.660	22	28.858	
December	29.348	29.328	29.332	23	29.724	10	28.870	
1879, January	29.398	29.328	29.331	2	29.730	15	28.836	
February	29.339	29.352	29.281	25	29.780	24	28.780	
March	29.422	29.321	29.235	10	29.666	19	28.966	
April	29.233	29.195	29.194	2	29.532	9	28.704	
May	29.263	29.255	29.195	7	29.540	2	28.802	
June	29.268	29.233	29.207	16	29.520	14	28.882	
July	29.288	29.252	29.236	5	29.450	11	29.080	
August	29.282	29.271	29.231	8	29.500	22	29.038	
September	29.389	29.407	29.324	23	29.624	2	29.110	
Annual Means	29.319	29.292	29.255		29.621		28.815	
1879, October	29.414	29.408	29.376	23	29.830	16	29.000	
November	29.292	29.290	29.250	19	29.782	7	28.800	
December	29.297	29.292	29.219	24	29.726	28	28.676	
1880, January	29.242	29.229	29.206	11	29.682	20	28.844	
February	29.282	29.263	29.209	18	29.876	11	28.636	
March	29.269	29.261	29.255	13	29.652	26	28.619	
April	29.216	29.209	29.015	30	29.678	18	28.576	The low pressure, April 18, corresponds to great Tornado at Marshfield, Mo.
May	29.251	29.237	29.207	15	29.580	29	28.792	
June	29.227	29.265	29.219	16	29.580	5	28.750	
July	29.324	29.314	29.272	21	29.476	2	29.102	
August	29.286	29.300	29.232	8	29.494	19	29.084	
September	29.376	29.358	29.304	19	29.582	25	28.998	
Annual Means	29.290	29.286	29.230		29.662		28.740	
1880, October	29.349	29.333	29.283	11	29.650	15	28.732	
November	29.400	29.384	29.366	20	29.808	10	28.821	
December	29.337	29.319	29.263	8	29.812	4	28.542	
1881, January	29.319	29.309	29.302	27	29.782	15	28.826	
February	29.252	29.312	29.239	15	29.638	26	28.686	
March	29.121	29.114	29.104	25	29.536	11	28.450	
April	29.226	29.224	29.216	28	29.528	11	28.826	
May	29.256	29.269	29.215	2	29.512	29	28.828	
June	29.216	29.209	29.157	30	29.446	5	28.892	
July	29.331	29.352	29.309	1	29.514	19	29.068	
August	29.306	29.300	29.239	24	29.420	29	29.060	
September	29.231	29.230	29.194	10	29.462	15-26	28.970	
Annual Means	29.279	29.280	29.241		29.592		28.808	
1881, October	29.300	29.307	29.284	12	29.570	28	28.712	
November	29.317	29.301	29.292	8-14	29.768	4-7	28.850	
December	29.325	29.320	29.303	14	29.670	27	28.850	
1882, January	29.301	29.309	29.287	21	29.860	25	28.800	
February	29.237	29.249	29.243	23	29.550	28	28.674	
March	29.274	29.276	29.262	23	29.708	17	28.816	
April	29.232	29.224	29.170	29	29.540	18	28.692	The low pressure April 18, corresponds to Tornado at Brownsville, Mo.
May	29.192	29.222	29.172	17	29.572	4	28.802	
June	29.211	29.209	29.159	5	29.500	2	28.800	
July	29.338	29.344	29.300	22	29.592	3	29.100	
August	29.327	29.321	29.280	19	29.544	4	29.140	
September	29.359	29.362	29.322	25	25.574	18	29.112	
Annual Means	29.284	29.287	29.256		29.621		28.862	

Dates.	General Means.			Maxima.		Minima.		Notes.
	Morning.	Noon.	Evening.	Date.	Reading.	Date.	Reading.	
1882, October	29.250	29.239	29.206	18	29.510	30	28.752	The lowest pressure yet recorded here (with one exception) occurred at noon, April 22, corresponding to Tornado in Mississippi and Louisiana.
November	29.377	29.364	29.346	2	29.666	22	29.026	
December	29.305	29.268	29.324	7	30.100	19	28.584	Highest Bar. yet noted. Extraordinary blizzard on 6th. Day of Venus-transit. Sun not vis. all day. Bar. 29.052 on 5th.
1883, January	29.331	29.327	29.332	18	29.800	29	28.862	
February	29.562	29.428	29.406	18	29.894	15	28.772	A month of unusually high pressure.
March	29.299	29.249	29.280	7	29.728	18	28.800	
April	29.132	29.122	29.087	24	29.488	22	28.532	There were four days of April with notable Tornado conditions, 13, 17, 18, 28. Tornadoes occurred at Kansas City, Racine, Wis., in S. E. Missouri, and S.W. Illinois, and Indiana and Ohio, and in Mississippi.
May	29.196	29.219	29.180	11	29.560	14 18	28.774 28.802	
June	29.220	29.219	29.196	4	29.370	8	28.864	Severe storms in Cen. Missouri on June 20 and 22. Dam. by hail 22. Bar. 29.100.
July	29.313	29.322	29.285	18	29.620	12	29.012	
August	29.373	29.368	29.311	6	29.550	21	29.129	
September	29.340	29.340	29.297	9	29.606	23	29.022	The low pressure on 23 corresponds to Tornado in Minnesota.
Annual Means	29.308	29.289	29.271		29.574		28.848	
1883, October	29.336	29.307	29.334	15-31	29.702	28	28.770	
November	29.321	29.309	29.286	12	29.878	25	28.746	
December	29.307	29.276	29.318	14	29.668	26	28.602	
1884, January	29.378	29.372	29.355	5	29.840	9	28.776	
February	29.224	29.227	29.241	9	29.600	18	28.654	
March	29.179	29.194	29.159	30	29.534	27	28.636	Barometer very low during March.
April	29.197	29.161	29.137	3	29.430	14	28.700	
May	29.224	29.222	29.183	29	29.516	1	28.898	
June	29.282	29.285	29.245	25	29.464	8	29.050	
July	29.242	29.248	29.206	20	29.446	4	29.024	
August	29.345	29.350	29.307	9	29.600	28	29.062	
September	29.291	29.290	29.285	12	29.530	28	29.000	
Annual Means	29.277	29.270	29.255		29.601		28.827	
1884, October	29.385	29.385	29.351	24	29.672	26	29.120	
November	29.296	29.318	29.304	6	29.698	22	28.730	The low pressure of 22 corresponded to Tornado in St. John's Parish, La.
December	29.322	29.275	29.268	31	29.742	6	28.692	
1885, January	29.364	29.313	29.299	18	29.760	11	28.574	
February	29.201	29.195	29.208	22	29.574	8	28.860	
March	29.334	29.322	29.283	23	29.606	20	29.039	
April	29.212	29.213	29.197	13	29.580	29	28.850	
May	29.209	29.206	29.173	1	29.424	5	28.860	
June	29.302	29.322	29.259	30	29.550	7	28.964	
July	29.291	29.300	29.258	17	29.496	14	29.114	
August	29.300	29.302	29.248	26	29.590	6	29.054	
September	29.304	29.298	29.297	18	29.520	8	28.850	
Annual Means	29.293	29.287	29.262		29.601		28.892	

MEAN AND EXTREME TEMPERATURES.

(ATTACHED THERMOMETER = *Ta*. EXT. THERMOMETER = *Te*.)

Dates.	MORNING.		NOON.		EVENING.		MAXIMA.		MINIMA.		Notes.
	T_a	T_e	T_a	T_e	T_a	T_e	Date.	T_e	Date.	T_e	
1877, Oct.				60.3			1	78.0	31	43.0	For the year 1877-78, only the means and extremes for noon are given for *Ta*. In the following seven years the extremes are the highest and lowest of all the Readings.
Nov.				42.7			10	55.5	29	20.0	
Dec.				45.0			20	61.0	1	27.5	
1878, Jan.				34.8			17	49.0	4	15.0	
Feb.				40.6			5	54.5	10	26.0	
Mar.				55.2			23	69.5	3	38.0	
April				62.9			21	80.0	3	49.0	
May				64.5			29	78.0	13	48.5	
June				74.6			20-30	84.0	8	64.0	
July				85.0			13-14	95.0	1	71.0	The mean Tem. at noon for Middle Decade of July, 11-20 incl., 92.7.
Aug.				82.4			18	92.5	30	60.0	
Sept.				73.5			5	86.1	20-26	58.0	
An. Means				60.1				73.6		43.3	
1878, Oct.	58.3	50.5	61.2	56.4	60.5	59.3	1	80.0	26	25.0	
Nov.	47.9	41.1	51.0	49.7	48.2	47.9	5	69.0	26	25.0	
Dec.	29.6	18.6	33.7	24.6	31.9	25.6	3	51.0	23	6.0^{n}	The letter n attached to a Temperature, means below zero.
1879, Jan.	28.2	19.8	32.7	25.9	29.8	25.3	27	54.0	3	16.7^{n}	
Feb.	34.1	27.9	38.3	37.8	36.4	35.1	24	58.5	25	4.0	
Mar.	45.8	43.0	48.7	48 3	49.2	52.7	7	79.5	13	13.0	
April	52.5	48.9	55.5	59.2	54.9	58.0	23	77.0	2	24.0	
May	66.6	62.8	74.3	74.5	62.6	62.6	25	87.0	5	46.5	
June	75.1	73.6	76.2	82.3	74.8	77.3	9	88.0	1-16	58.0	
July	78.3	76.0	82.1	82.3	79.5	81.2	9-11	90.1	29	64.0	
Aug.	75.3	67.2	80.8	81.0	72.7	80.2	2-21	88.0	15	58.0	
Sept.	65.5	56.8	68.6	69.9	68.6	70.6	27	83.0	9	45.0	
An. Means		48.85		57.67		54.65		75.42		28.32	
1879, Oct.	64.0	56.5	68.2	65.7	68.2	67.0	8	82.0	23	31.0	
Nov.	47.4	39.9	51.2	48.1	50.5	48.9	7-8	71.0	19	15.0	
Dec.	32.4	23.0	35.3	30.0	34.5	31.4	4	61.0	25	7.0^{n}	
1880, Jan.	42.6	37.0	45.3	44.0	41.0	45.2	3-18	60.0	30-31	21-0	
Feb.	38.9	31.4	42.6	41.1	41.0	41.4	27	70.0	28	13.0	
Mar.	42.2	35.1	45.4	47.0	45.4	47.3	26	72.0	13	14.0	
April	54.8	48.5	60.6	61.5	60.8	62.8	23	81.0	6	28.0	
May	70.7	61.9	72.7	74.5	72.8	74.1	23	86.0	1-2	54.0	
June	71.8	68.6	73.8	78.1	74.7	76.3	23	85.5	5	61.0	
July	75.9	62.9	78.7	82.9	79.2	81.8	13	93.0	21	59.0	
Aug.	75.5	70.0	81.5	85.1	82.6	85.0	18-19	98.0	14	63.0	
Sept.	67.7	59.5	68.8	71.5	70.6	70.5	2	85.0	28	45.0	
An. Means		49.52		60.8		60.1		78.7		32.2	
1880, Oct.	55.8	45.1	59.1	56.0	58.9	59.0	10	78.0	17	27.0	
Nov.	37.0	26.2	40.0	35.5	39.9	34.7	12	60.0	17-20-21	8.0	
Dec.	29.8	20.6	33.8	27.1	30.0	28.4	23	54.0	28	15.5^{n}	
1881, Jan.	25.3	15.9	29.4	22.6	26.7	23.8	29	42.5	13	10.0^{n}	
Feb.	30.3	22.1	35.6	34.3	33.7	31.4	26	57.5	15	2.0^{n}	
Mar.	36.4	29.7	41.3	40.0	40.0	40.0	24	66.5	4	16.0	
April	47.9	43.7	51.5	53.3	51.7	54.7	17	78.0	14	13.0	
May	67.2	65.2	72.6	73.9	71.8	74.3	13-26	81.0	2	47.0	
June	71.1	70.6	79.6	81.2	79.6	81.3	29	93.0	22	62.0	
July	80.3	75.6	83.4	85.5	84.3	88.2	11	96.5	26	62.0	
Aug.	78.6	73.8	85.6	89.6	86.2	87.8	17	104.5	21	65.0	
Sept.	72.7	66.7	77.6	78.4	77.4	77.4	5	97.0	16	46.0	
An. Means		46.3		56.5		56.7		75.7		26.5	

Dates.	Morning.		Noon.		Evening.		Maxima.		Minima.	
	T_a	T_e	T_a	T_e	T_a	T_e	Date.	T_e	Date.	T_e
1881, Oct.	59.9	55.4	63.2	62.5	62.6	61.8	3-7	78.0	18	42.0
Nov.	43.2	35.6	47.0	44.0	45.8	43.2	6	61.0	23	10.0
Dec.	41.6	34.7	44.8	41.8	44.13	42.4	6	64.0	31	10.0
1882, Jan.	34.2	27.2	34.7	32.9	37.2	34.3	7	59.0	22	4.0
Feb.	40.9	37.0	41.4	44.5	45.3	47.0	12	69.0	20	15.0
Mar.	45.9	35.9	49.9	45.2	49.0	50.0	17	70.0	5	22.0
April	55.3	51.4	60.1	59.6	58.9	57.6	2	78.0	10	30.0
May	58.3	54.8	64.3	60.1	61.5	61.7	4	76.0	11	41.5
June	71.2	69.3	75.8	75.6	75.3	77.7	24	93.0	2-19	56.0
July	72.7	70.0	77.9	76.3	77.3	76.7	27	86.0	3-6-18	61.0
Aug.	77.7	69.6	79.9	79.2	78.9	78.4	25	87.0	9	61.0
Sept.	67.4	61.2	73.9	73.0	73.0	67.4	18	95.0	20	46.0
An. Means		50.2		57.9		58.2		76.3		33.2
1882, Oct.	57.4	51.6	66.0	63.6	64.2	64.5	4	78.0	18	38.0
Nov.	46.1	40.1	50.2	46.2	48.4	45.1	10	71.0	13	21.0
Dec.	35.2	25.9	37.5	33.6	35.7	32.5	19	54.0	6	10.0^{n}
1883, Jan.	24.4	12.6	29.1	20.0	26.4	20.8	12-29	41.0	20	14.0^{n}
Feb.	31.1	22.9	33.1	30.4	31.4	29.8	28	57.0	4	9.0^{n}
Mar.	38.2	31.8	39.7	40.5	42.2	41.3	1	62.0	7	17.0
April	58.3	49.8	59.3	62.1	59.3	61.9	13	80.0	24	35.0
May	60.5	56.0	65.0	65.4	65.1	66.6	2	83.0	21	37.0
June	70.2	68.8	73.2	74.2	73.2	76.5	29	85.0	14	58.0
July	74.7	74.6	80.9	80.9	80.6	80.9	12	93.0	30	59.0
Aug.	70.9	64.7	76.9	78.4	76.7	77.9	17-18	87.0	24	55.0
Sept.	59.2	54.5	67.4	73.7	70.1	70 6	1	90.0	9	41.0
An. Means		46.11		55.75		55.70		73.42		27.33
1883, Oct.	54.0	48.3	59.0	58.4	58.0	57.5	8	84.0	31	31.0
Nov.	46.4	38.9	50.6	50.0	48.9	41.0	25	70.0	16	13.5
Dec.	37.9	28.6	39.1	35.2	40.0	37.1	5	59.0	27	5.0
1884, Jan.	25.6	14.3	29.3	23.1	26.7	21.0	29	55.0	5	28.0^{n}
Feb.	32.7	24.3	34.4	32.0	34.6	31.5	3	54.5	28	1.0
Mar.	41.5	35.7	44.4	44.1	42.5	44.6	27	65.0	4-5	8.0
April	50.5	46.1	54.7	53.4	52.8	54.2	30	74.0	21	43.5
May	63.3	57.3	66.6	68.3	67.3	65.4	10	77.0	2	44.0
June	70.5	68.7	78.2	77.8	79.0	74.9	30	85.5	10	50.5
July	75.6	72.2	81.7	80.9	80.7	80.3	8	96.0	14	66.0
Aug.	71.5	67.1	77.4	77.0	76.7	70.0	2	86.0	10	57.0
Sept.	70.8	65.0	76.4	77.3	75.5	75.2	8	85.0	25	49.0
An. Means		47.21		56.46		54.40		74.25		28.37
1884, Oct.	53.8	52.6	67.7	64.9	65.0	63.9	4	83.5	24	33.0
Nov.	45.8	35.3	50.6	47.1	48.9	44.4	9	66.0	24	17.0
Dec.	30.7	20.5	34.6	27.6	32.3	25.3	4	49.0	31	6.0^{n}
1885, Jan.	23.5	13.0	27.3	16.6	24.5	19.0	10	40.0	22	13.5^{n}
Feb.	24.9	14.7	29.8	24.4	30.7	19.6	7	47.0	10	17.0^{n}
Mar.	38.4	32.3	42.3	43.0	40.3	38.8	31	60.5	17	15.0
April	51.7	47.6	55.7	57.5	53.9	53.7	21	73.0	3	34.0
May	62.1	57.0	67.2	67.4	63.9	64.2	23	80.0	7-8	35.0
June	70.7	67.1	76.0	75.2	73.9	73.1	2-7	84.0	9	53.0
July	75.8	74.8	83.4	83.8	82.0	80.0	30	95.0	2	64.0
Aug.	73.8	68.2	80.8	79.0	78.6	74.8	8	92.0	18-29-30	61.0
Sept.	67.3	61.2	72.5	70.9	70.7	69.3	21	79.0	3	41.0
An. Means		45.4		54.8		52.2		70.8		26.4

MONTHLY PER CENT. OF CLOUDINESS, RAINFALL, AND SPECIAL PHENOMENA.

Dates.	Per cent. of Cloudiness.	Rainfall.	Special Phenomena.
1877, October	47	4.873	First frost October 4. A month of clouds and showers, varied by a few fine days.
November	51	2.514	Indian Summer, 14–19. Violent change 28. Much dreary weather.
December	60	3.210	Part of the month very unseasonable, 16–26. Resembled May, grass growing and buds swelling. Glorious rainbow in N.W at 7½h. on 19. From 24 to 31 the sun was rarely visible. Clouds, fogs, mist, rain and mud, in general chaos.
1878, January	26	1.122	Many of the finest days known to this climate. Bitter cold 4. Sun dogs. Few light snows.
February	27	3.133	On 20, severe thunder storm, 4h.–10h, followed by continuous rain and low Bar. for 20h. A number of beautiful days in this month. Brilliant meteor on 16, at 19h. S.W.
March	22	4.384	Fine open weather a great part of month. Morning dews, like May, from 12–18. Cold, cutting N.E. wind on 20. Violent wind at 14h on 26, from S.W.
April	18	2.713	Month of April generally fine, open weather. Storms on 9, 21, 22. Fogs and dews, 26–30.
May	23	3.992	Weather generally good. Very severe hail-storm at 15h. on 17. Wind at first S.E., then W., and finally N.E. Wind very severe.
June	20	2.794	Month of fine weather. Tornado at Richmond, Mo., June 1.
July	20	0.832	Month very dry and hot. Very little rain. Crops much injured. Total solar eclipse July 29.
August	17	1.389	Month dry and hot. A few showers.
September	30	1.953	Greater part of month dry and hot. Strong and continuous winds on 19, 25, 29. Frost on 20. but light.
Annuals	30	32.909	
1878, October	29	1.759	A month of very fine weather. Ground had a frozen crust on 27.
November	41	0.462	Month dry. Much chilly weather. Severe shock of earthquake 23½h. Nov. 18. Shook buildings so as to awaken the sleepers; rattled windows and furniture.
December	56	4.197	Snow on 16, 18 in. Air full of ice crystals from 15 to 30. Sun dogs 17, Excessive frosts and congealed mists on trees for several days at last of month.
1879, January	40	0.751	Some bitter cold weather in first part of month. Continued frost on trees from 11–14. Very fine weather in latter part of month.
February	41	0.121	Very little rain. A great amount of dreary, chilly weather. A smoky mist, with a peculiar penetrating odor on 26–27.
March	40	0.434	Little rain. Many sudden changes, particularly on 14. Heavy sleet on 2. Latter part of month very dry, windy and dusty.
April	40	1.520	First part cold and dry. Showers and nice weather a considerable part of the remainder.
May	35	1.574	Great part of month warm and dry; very dry in latter part.
June	35	7.591	First part of month dry; after 13 some heavy rains. Storms, 25–26.
July	27	3.359	First and last part of month dry. Middle had refreshing showers.
August	28	0.468	A month of hot, dry weather.
September	31	3.285	Month generally cool, with some beautiful weather. Storm on 10.
Annuals	37.0	25.521	Nearly 10 in. of rain below the normal. The great snow of Dec. did not melt, as usual, but was absorbed by the thirsty ground, and proved the salvation of the wheat.
1879, October	20	1.451	Heavy frosts between 17–24. Generally fine weather.
November	36	1.827	Part of month very dry. Very fine weather middle and latter part. Ground frozen 19.
December	51	1.820	Much deary, dismal weather. Sleet 30–31. Stinging cold 25.
1880, January	44	0.669	Magnificent rainbow at sunrise on 3. Fogs 1, 4, 5, 6, 7. Smoky 24–25.
February	29	1.671	Strong winds 8–27. Storms, with lightning and thunder, 11–17. Severe change to cold 28.
March	43	1.240	Strong winds 26–27. Heavy frosts 4, 5, 18, 19, 20. Snow 3 in. 11. Thunder storms 24, 28, 30.
April	38	0.992	Very dry month. Frosts 6, 7, 8, 10, 26, 30. Hail storm Boonville and Keytesville 22. Tornadoes 15–22.
May	32	5.764	Greater part of month dry. From 25–31 cool, with abundant rain.
June	32	1.057	Very dry greater part of month. Fine weather for harvest.
July	25	3.780	Very dry and hot latter part of month. A remarkably rare thunder cloud from the east at 16h. on 31. Fogs 4, 5, 14, 21.
August	26	6.080	Very dry and hot till 20. Heat extraordinary. On 31, heavy rain, 2¾ inches.
September	26	2.671	Very beautiful month. Light snow 9–29. Heavy rain 26. Fog 4.
Annuals	33.5	29.022	
1880, October	26	1.505	Heavy frosts 2, 11, 21, 22, 23, 28, 30, 31. Heavy winds 13, 15, 16. Fine rainbow 13, at sunset.
November	51	1.587	Extremely cold weather. Missouri river blocked 23. Very high pressure 21.
December	60	0.685	Extremely cold weather 28–29. Great fall of temperature 26. Solar halos followed the sun all day 27–29.
1881, January	56	0.000	Month exceedingly cold, dreary, and dry.
February	60	4.510	Very inclement month. Snow 11–12 from 10 to 12 in., affording 1.53 in. of water.
March	47	3.236	Great storm 18–19. Remarkable drifts of snow. Very severe month.
April	49	2.293	First half of month very cheerless and unfavorable; latter half very favorable. High water on 30.
May	50	4.231	Numerous showers. Month very favorable to vegetable growth.
June	35	5.463	Numerous heavy showers and winds. Difficult harvest.
July	20	1.743	Unusually warm. Latter part very dry.
August	21	1.150	Excessively hot and dry. Temperature above 90° on 15 days.
September	34	3.665	The greater part of month excessively dry, with strong E. and S.E. winds. Heavy and continuous rain on 30.
Annuals	42.4	30.068	

Dates.		Per cent. of Cloudiness.	Rainfall.	Special Phenomena.
1881,	October	55	4.882	Month mild and seasonable. Little frost.
	November	44	1.289	Greater part of month pleasant. Sleet and snow 18-19.
	December	49	1.685	Greater part of month pleasant. Fine rainbow 27 in N.E. at 14½h.
1882,	January	54	0.780	An unpleasant month, freezing and thawing alternately.
	February	42	3.050	Much freezing and thawing. Great sleet 19, 20, 21. Very muddy.
	March	46	2.683	The month unusually mild. Strong wind 21.
	April	44	2.455	Changeable month. Great aurora 16, with immense sun-spots and magnetic disturbance. Tel. oper. independent of batteries. Severe change to cold 11. Tur. at Browosville 18.
	May	54	3.938	Changeable and cool month. Severe frost 24-25.
	June	36	4.768	Seasonable and favorable to growth. Remarkable streamers from the sun, after sunset, June 25, extending from horizon to horizon through the zenith. Lune-shaped, and margins blue and violet, and middle red. Direction from W. by N. to E. by S.
	July	30	4.598	Seasonable. Frequent showers. Harvest very difficult and late.
	August	30	1.710	Month mild. Very wet first decade, and very dry and dusty last two.
	September	26	4.058	Early part of month very dry. Ground very hard. Latter part seasonable.
Annuals		42.5	35.905	
1882,	October	33	4.188	The comet Cruls very brilliant all the month. Great frosts 16, 18, 21, 22.
	November	51	3.960	Grand auroras 12-18. Great mag. disturb. Rupture of sun-spots. Great fall of rain and hail night of 9. Great change to cold 11, herald by a flight of cranes southward.
	December	63	1.135	Terrific ch. of weather Dec. 6-7. Great bliz. on 6, day of Venus-transit. Highest Bar. ever noted here on morning of 7; ch. of 1.516 in Bar. bet. 7 and 20. Great frosts 22-30.
1883,	January	58	1.410	The month of January one of unusually low temperature and great vicissitudes of weather. No rain. Numerous light snows. Severe storms 10, 11, 19, 29, 30.
	February	48	3.470	Weather for February very variable, several abrupt and severe changes to cold. Numerous freezes and thaws. High average pressure.
	March	46	1.440	Much fine weather up to 23. Last 8 days dismal, cloudy, damp and cold.
	April	43	1.067	Greater part of Apr. dry and cool. Frosts 23, 24, 29.
	May	41	5.767	Very cool and showery; first 16 days very dry. Heavy frosts on 5, 11, 22, 23, that of 22 doing much harm. Remarkable tor. 13, 17, 18, 28. Tornado conditions indicated.
	June	44	8.085	On 20 and 22 very severe local storms.
	July	37	3.354	Gen. favorable. Severe storm on 13.
	August	38	0.375	A very dry month. Heavy fogs on 9 mornings. Numerous clear, but smoky days.
	September	26	0.490	Very dry month. Numerous smoky days.
Annuals		44.2	34.841	
1883,	October	54	7.580	Month very wet. Weather mild. Some beautiful days.
	November	37	1.275	Severe storm Nov. 5. Hurricane at Springfield, Mo.
	December	45	0.935	This month and part of October remarkable for the glowing skies of evening and morning.
1884,	January	46	1.170	Very severe winter month, and long to be remembered. On 28, ther. 28°. Many animals froze, particularly on trains.
	February	58	2.008	All extremes in February. Very changeable and disagreeable.
	March	55	2.305	First 10 days very disagreeable. Cold and bleak winds and weather, Latter part of the month fine growing weather. Very low pressure most of the month.
	April	59	3.404	Very low pressure most of the month. Frequent showers. 21, 22, 10 inches of snow. Rains gentle.
	May	43	3.305	Month cool. Latter part dry. Heavy dews.
	June	43	3.025	Seasonable, but cool, except latter part.
	July	37	12.161	Excessive rains. Harvest exceedingly difficult. Much grain and hay ruined. Intersecting rainbows on 24 at 18h; a very striking and inexplicable phenomenon. See NOTE.
	August	34	2.755	The first half of August dry, latter half showery. Severe thunder storm 18.
	September	28	8.385	Seasonable month. Rains delayed the wheat sowing.
Annuals		45.0	48.305	
1884,	October	28	4.530	Very seasonable. Many fine days.
	November	29	1.975	First half of November quite good; latter half very changeable.
	December	66	2.950	One of the worst months for all sorts of bad weather ever known in Missouri.
1885,	January	49	1.840	January worse than December, if possible.
	February	43	0.650	No rain. Several snows. A month of very severe and continued cold.
	March	41	0.000	No rain. Greater part of month pleasant. Dry winds near the middle.
	April	56	6.475	Cool, backward, and full of showers and clouds.
	May	43	2.230	Former part of month dry and cool; latter part showery and cool.
	June	43	6.580	Month showery. Numerous storms. Destructive storm at Glasgow 20.
	July	45	3.160	Latter part of month excessively hot and exhausting. Moisture abundant.
	August	33	3.560	Former part of month showery; latter part dry. Hot sun and cool nights.
	September	40	6.120	First half of month showery, 14-27, very fine weather. 27-30, clouds and rain. From 14-26, the radiance of the sunsets remarkable.
Annuals		43	40.070	The entire year most favorable to growth. Grass never withered a day. Perfectly green all summer and autumn.

COMPARATIVE VIEW OF ANNUAL RESULTS FROM OCT. 1, 1877, TO OCT. 1, 1885.

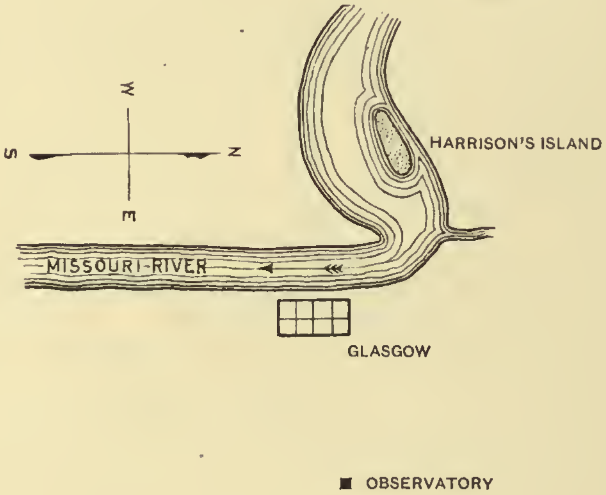
Years.	B	B	B	B	B	T_c	T_c	T_c	T_c	T_c	Clouds.	R
	Mean An. Pressure. Morning.	Mean An. Pressure. Noon.	Mean An. Pressure. Evening.	An. Maxima Pressures.	An. Minima Pressures.	Mean An Tem. Morn.	Mean An. Tem. Noon.	Mean An. Tem. Eve'g.	An. Max. Temperature	An. Min. Temperature	An. M'ns of Cloud.	An. Rainfalls in Inches.
1877–78		29.225		29.516	28.839		60.10		73.60	43.30	30	32.909
1878–79	29.319	29.292	29.255	29.621	28.815	48.85	57.67	54.65	75.42	28.32	37	25.521
1879–80	29.290	29.286	29.230	29.662	28.740	49.52	60.80	60.10	78.70	32.20	33.5	29.022
1880–81	29.279	29.280	29.241	29.592	28.808	46.30	56.50	56.70	75.70	26.50	42.4	30.068
1881–82	29.284	29.287	29.256	29.621	28.862	50.20	57.91	58.20	76.30	33.20	42.5	35.905
1882–83	29.308	29.289	29.271	29.574	28.848	46.11	55.75	55.70	73.42	27.32	44.2	34.841
1883–84	29.277	29.270	29.255	29.601	28.827	47.21	56.46	54.40	74.25	28.37	45.0	48.305
1884–85	29.293	292.87	29.262	29.601	28.892	45.40	54.80	52.20	70.80	26.40	43.0	40.070
	29.293	29.277	29.253	29.599	28.804	47.66	57.50	56.00	74.94	28.90	41.1	276.641

It thus appears that between the noon of October 1, 1877, and October 1, 1885, the rainfall at the Observatory was 276.641 inches = 23.053 feet; and giving an annual mean for the eight years of 34.58 inches. It also appears that the year 1879 was at the extreme of dryness; while the year 1884 was at the extreme of moisture. The diurnal oscillation of the barometer is fully shown by these observations.

NOTE ON THE INTERSECTING RAINBOWS OF JULY 24, 1884.

As this phenomena was unique, and so far as I know, without previous record in any work on physics or meteorology, I think it not irrelevant to speak of it more particularly. The day had been warm and threatening. At noon the barometer reading was 29.224, external thermometer 87. Late in the evening a very angry and extensive thunder cloud rose in the N.W. and passed to the S.E. It was attended by moderate rain, and a wind less severe than was anticipated. After the rain had ceased the sun shone out brightly, and entire stillness pervaded the air, while the dense mass of cloud, reaching almost to the zenith, and extending from beyond the N.E. almost to S.W., seemed intensely dark, smooth and watery. Very soon the usual phenomenon of the rainbow, both primary and secondary, made its appearance, in unusual brightness, the arch of the bow having nearly the maximum altitude, as the sun was near the western horizon. After some minutes, my son, Prof. H. S. Pritchett of Washington University, called my attention to a third bow, intersecting the primary bow in the S.E., at an angle of about 30°, and at a point about 40° above the horizon. The arc of this third bow extended some 20° or more on each side of the point of intersection. It was not so bright as the primary bow, but much brighter than the secondary. We both watched it for some minutes, and with no little surprise. My son then went into the house, but I remained outside and continued to look at it. The arch above was not filled out, but turning my eyes to the N.E., I saw the same phenomenon of intersecting arc on that side, and under like angle and altitude. I then called out my son, and we both watched it quite a while, for it must have lasted fifteen or twenty minutes.

Such is the fact with its antecedents and conditions. I became so interested in this remarkable phenomenon, as to write to several physicists and meteorologists, describing it and asking an explanation. From some no reply ever came, while from others came replies courteous and even satisfactory. It was suggested that the phenomenon was purely local, and depended on a certain concurrence of local and general conditions. That the explanation suggested may be understood, I insert a sketch showing the relative position of the Observatory and Missouri river, with its direction and curve at Glasgow.



The explanation suggests that the third bow was due solely to reflection from the broad and quiet surface of the river above the curve. Allowing this to be true, the center of the third bow would be elevated above the center of the primary twice the angular altitude of the sun, and hence would necessarily intersect the primary. To produce the phenomenon, on this supposition, a concurrence of these five things was necessary. 1. A suitable rain-cloud in the S.E. for the background. 2. The air so still as not to agitate the water. 3. A proper azimuth for the sun. 4. A proper altitude for the sun. 5. The observer so situated that the reflecting surface and sun shall to him have the same azimuth. The probability that all these conditions shall concur, at any one time, is indeed very small; still if this be the explanation, it seems strange that in regions of country abounding in small lakes the phenomenon has not been previously noted.

TIME SERVICE OF MORRISON OBSERVATORY.

SIGNALS TO KANSAS CITY.

On June 3, 1880, in accordance with arrangements made with Major Garner, Superintendent of the Union Depot, Kansas City, we commenced to send automatic clock signals from the Observatory, to mark the instant of 4 P.M., Kansas City mean time. These signals were received and noted in the main Telegraph Office, and also in the Union Depot. They were sent over the line of the Chicago and Alton R.R., but were not officially adopted by that road till some months after. At the beginning of the following year, a temporary interest in the matter of correct time was aroused among the citizens, and a time ball was mounted on the tall building of Bullene, Moores & Emery. The entire enterprise was under the direction of Mr. Henry S. Pritchett, then Astronomer in the Observatory. The ball was successfully dropped over the distance of 110 miles by the standard clock of the Observatory. So far as we are informed, this was the first time-ball service west of the Mississippi. This service was entirely efficient and satisfactory, so long as the necessary attention was bestowed on raising the ball at the appointed time, and adjusting the electric apparatus to be acted on by the clock. But as no fund was provided by the citizens to maintain this part of the service, after some months, failures began to occur, and the time ball was discontinued. The signals, however, continued to be sent, as before, till November 4, 1882, except that after March 26, 1881, they were sent at mean noon. After November 4, the noon signal was discontinued, and only the morning signal at $9^h\ 30^m$ has gone to Kansas City. On our part this service was entirely gratuitous.

ST. LOUIS TIME SERVICE.

On March 26, 1881, we commenced to drop a time ball from a high staff placed on the Jaccard Building, corner of Fifth and Olive Streets, St. Louis. This ball, like several others in the West, was erected under the superintendence of Mr. H. S. Pritchett, then identified with the Observatory. The signals were made automatically by the Observatory clock, at St. Louis mean noon. The line of wire over which they were transmitted was nearly 200 miles. For their transmission over the wires of the Western Union Telegraph Company, the Eugene Jaccard Jewelry Company entered into a special contract with the District Superintendent, under which they paid to him $15 per month; while on the part of this Observatory they were entirely gratuitous.

As this service was subsequently superseded by the Washington University time service, under the direction of Prof. H. S. Pritchett, it is but simple justice to preserve in the Memorials of this Observatory a record of the fact, that it rendered for so long a time and so successfully, under peculiar difficulties, and in the face of ungenerous opposition, and without a cent of remuneration, for the great city of St. Louis, this useful time service. I, therefore, transcribe from the Observatory Records of May 2, 1882, a letter of Mr. C. C. Adams, Manager of the Eugene Jaccard Jewelry Company, written in answer to one addressed to him April 26.

St. Louis, Mo., *May 1, 1882.*

Mr. C. W. Pritchett,
Director of Morrison Observatory, Glasgow, Mo.:

Dear Sir, — Your note of 26th reminds us of a neglected duty. The time service has been efficient and highly satisfactory, and if you will continue it for the present, at least, we shall be very glad. We have had some talks with your son (Prof. H. S. Pritchett, then of Washington University), in reference to a change. We expected in the beginning to extend the signals, but the Western Union Telegraph Company has put an embargo on that by their heavy tax for wires around the city. In a few days we may be able to speak more definitely. In the mean time we assure you of our appreciation of the service, though we must confess that the public at large do not exhibit much interest in it.

With due respect we are yours, etc.,

EUGENE JACCARD JEWELRY COMPANY.
C. C. Adams, *General Manager.*

The following telegram was received July 2: —

St. Louis, Mo., *July 1, 1882.*

Observatory, *Glasgow, Mo.:*

Thirty days from date, the Eugene Jaccard Company will discontinue time ball.

J. H. TOPLIFF, *Chief Operator.*

Accordingly the signal was sent for the last time July 31, and was answered OK — A. The letter A. being the signature of the Western Union Office, St. Louis.

TIME SERVICE ON RAILROADS.

On April 24, 1882, we began to send official time signals on the Chicago & Alton Railway. These signals are sent from the Observatory every morning, except Sunday, at $9^h\ 30^m$. Since November 18, 1883, they have been referred to the VI. hour meridian from Greenwich, in accordance with general agreement. The time indicated by these signals is therefore fast of our own local time, by $11^m\ 18^s.03$ — it is fast of St. Louis local time 49^s, and is slow of Chicago local time $9^m\ 33^s.22$. These slight differences are entirely forgotten in the general convenience resulting from a uniform time standard over all North America. The wire is occupied in sending the signals only $1^m\ 30^s$. They are sent on an open circuit, the main line being held open for a few seconds before beginning. At $9^h\ 29^m\ 0^s$, the open circuit is first closed by the clock. On the first series, it continues to be closed every second for 45 seconds, or until $9^h\ 29^m\ 45^s$. The circuit is then left open for 15 seconds, or until $9^h\ 30^m\ 0^s$. Precisely at $9^h\ 30^m\ 0^s$, the clock again begins to close the circuit on the second series, and continues to do so for 30 seconds, when the signals cease at $9^h\ 30^m\ 30^s$. For each clock beat of the second series, a second beat is interpolated by hand (or by an extra pendulum), at about the interval of $0^s.3$, thus making the second series one of continuous double beats. This is done for the convenience of train dispatchers and others who wish to take note of the signals, as it gives an audible distinction between the series before and after the critical signal, at $9^h\ 30^m$. Sometimes the circuit may be interrupted on one series, and not on the other, so that by this distinction train men and others have four independent opportunities to identify the minute and second, as thus shown —

Beginning of first series of single beats,		$9^h\ 29^m\ 0^s$
End of first series of single beats,		$9^h\ 29^m\ 45^s$
Main Signal.	Beginning of second series, double beats,	$9^h\ 30^m\ 0^s$
	End of second series, double beats,	$9^h\ 30^m\ 30^s$

The wire over which these signals go is one of the busiest in the West, and generally there is no opportunity to announce "time"; but the signals break into any message then in transit. Operators (except novices on the line) have learned to hold off and wait. Indeed they can do nothing else, since the clock holds the line. Keeping it open $\frac{9}{10}$ second, and closing it $\frac{1}{10}$. Even should a key be thrown open part of the time the programme of signals shown above affords abundant opportunity to fix the minute and second by having the beginning or end even of a partial series.

As the standard clock of an Observatory cannot be changed to accommodate fractions of a second, it is found best (saving the expense of a hack clock) to employ a pendulum delicately mounted and adjusted to mean time seconds, yet unconnected with clock work. Such a pendulum will vibrate uniformly for fifteen or twenty minutes, or even longer. The circuit is closed at the lowest part of its arc by contact with a globule of mercury. It may be set in motion so as to make the contact at the exact fraction of a second required. This is done by pressing against the pendulum arc with a finger till it stands at the highest point, then abandoning it to gravity at the proper instant. This adjustment is made one or two minutes before the signals begin, and if necessary, is repeated till precision is attained. When the free pendulum has been adjusted to the instant to be noted, it is cut into the main line just as the clock.

It is much to be regretted that we have been so restricted in sending signals to numerous towns and places of business which have applied for them. It has been in our power to do a useful work, and at the same time to make some money for ourselves and the Telegraph Company. But the very high rates demanded for the use of wires have entirely closed the door against us.

TRANSIT OF MERCURY, 1878, MAY 5–6.

As careful preparation was made to observe the transit of Mercury across the disc of the sun, May 5–6, as my resources would allow. The aperture of the 12¼ inch equatorial was reduced to 7 inches diameter by a paste-board cap. To make sure of opportunity, several nights in advance, the focal adjustments of the eye-piece were most carefully made by turning the instrument successively on the moon, *Castor*, γ *Leonis*, and finally on *Uranus* and his satellites. The planet being concealed by sliding the eye-piece, the two outer satellites were very distinct, even to unpracticed eyes. The micrometer eye-piece employed has a magnifying power of 275. The zero of the position circle was newly tested by causing the transverse micrometer thread to bisect stars in transit across the field. It was found to stand at $P_0 = 130°$, as for the previous two months.

The day was all that could be desired. Till noon a very slight haze was perceptible, so thin and transparent as rather to facilitate than to hinder the observations. In the afternoon this barely perceptible vapor passed away, and the sky was intensely blue.

Fifteen minutes before the computed time of first contact, the equatorial as previously adjusted, and with a shade of blue glass screwed over the eye-piece, was turned on the sun, and the position circle set to read 85°, thus making the transverse thread have an inclination of 315°, to the direction of diurnal motion. The fixed micrometer thread (*B*) farthest from the screw-head, was made tangent to the sun's limb, the driving clock was set to work, and the instrument clamped. The movable micrometer thread was then brought near enough to the fixed thread to cut off a fine segment of the sun's disc. So successful were the adjustments, that when the protruding segment of Mercury was first detected it was in contact with the transverse thread on the north side. The time of the various phases was noted on the chronograph, the circuit being broken by sidereal chronometer, Negus 1590. The chronometer was compared both morning and evening, just preceding the observation, with the standard sidereal clock, Frodsham 1369. The error and rate of clock were deduced on May 4 and 6, from observations of the Washington time stars, on the meridian circle, all the constants of which were newly determined for those evenings. On May 4, the following stars were observed, and the clock error and rate deduced by the method of least squares.

12 Canum Venaticorum,
Polaris, *sub. polo*,
ζ *Virginis*,
η *Ursæ Majoris*,
η *Bootis*,
α *Draconis*,
α *Bootis*, *Arcturus*,
5 Ursæ Majoris,
ε *Bootis*,
α^2 *Libræ*.

The deduced clock correction and daily rate, on May 4, sidereal hour $13^h.814$, were —

Clock error $= \triangle t$ of 1369 $= -6^s.19$ $\qquad$ $\delta t =$ daily rate $= -0^s.04$

From which the chronometer rate and error were found to be for $13^h.814$,

$$\triangle t = -2^m\ 7^s.81 \qquad \delta t = -0^s65$$

The stars used on May 6, were *o Virginis*, β *Corvi*. 12 *Canum Venaticorum*, *Polaris sub. polo*, and ζ *Virginis*, from which the clock error and rate deduced for sidereal hour 12.175, were —

$$\triangle t = -6^s.29 \qquad \delta t = -0^s.05$$

and from these, the chronometer error was found —

$$\triangle t = -2^m\ 9^s.14 \qquad \delta t = -0^s.66$$

To guard against any accident at the chronograph, an assistant noted the mean time by an excellent watch, the error and rate of which were well known. Though no occasion was afforded to rely on this additional notation of time, it served as a check on the reductions. The assistant also noted the phases, as signaled by the observer at the telescope.

Phase 1.—External Contact. The protrusion of Mercury on the sun's disc, when first detected was not so flat, nor the encroachment so great, as drawn in Prof. Newcomb's "*Instructions for Observing the Transit of Mercury,*" Fig. 2, Ext. Cont. The notch or protruding segment was recognized at $21^h 1^m 58^s$, L.M.T. From actual observation of the emergence of a similar segment at egress, I infer that true external contact occurred 8^s earlier. Hence I note true external contact at $21^h 1^m 50^s$. I could detect no arc of light enveloping the small segment, nor with the most scrutinizing search could I detect Mercury outside of sun's disc.

Phase 2.—Phenomenon of the Cusps. I noted the time corresponding to the position of the cusps in Newcomb's Fig. 2, I. It was the mean of several estimates. I noted no blunting of the points at this stage of the cusps. The time noted was $21^h 4^m 4^s$, L.M.T. The cusps remained very distinct and steady, continually growing thinner, and with sharper points approaching each other.

Phase 3.—First Internal Contact. The cusps appeared entirely steady and distinct until very near the time of contact. The undulations were much fewer than I had expected to see. My eye ran rapidly along the approaching curves of the cusps, disregarding the undulations until the directions of these curves met at the same point on the sun's limb. This was the moment noted for internal geometric contact. The edge of sun's limb was also surprisingly steady and well defined, showing only a few apparent scratches or minute notches. The shading of the eye-piece was such as to give the face of the sun a mild blue tinge, free from all glare; and the impression on my eye was that it was not more than twice as bright as a perfectly clear southern sky, illumined by the sun when two hours above the horizon. The moment noted for first internal geometric contact was $21^h 4^m 34^s$, L.M.T., corresponding to $22^h 7^m 40^s$, W.M.T.

Phase 4.—The Dark Band or Ligament. For a few seconds subsequent to my estimate of the internal contact, the excessively narrow interval between the points of the cusps remained, and assumed the form of a very narrow band or ligament, with curves slightly convex to each other. This narrow band faded rapidly away and disappeared with a slight apparent curvature towards the sun's limb. About the time of change from double to single curvature I noted the time to be $21^h 4^m 43^s$, corresponding to $22^h 7^m 49^s$, W.M.T. My impression is, that this phase corresponds very nearly to the first undulation of sun-light round the entire planet, or to the vanishing point of the cusps. If the first glimmer of sunlight round the entire planet is to be taken for the internal contact, it must have occurred very nearly at $22^h 7^m 46^s$, W.M.T.

Phase 5.—The Perfect Disc of Mercury on the Sun. At $21^h 4^m 53^s$, L.M.T., corresponding to $22^h 7^m 59^s$, the planet was certainly clear of the sun's limb, and appeared as a perfect circle with a measurable band of light between it and the limb. While I can not assign the exact instant when all distortion ceased, it certainly occurred between $21^h\ 4^m\ 43^s$ and $21^h\ 4^m\ 53^s$, L.M.T.

Phase 6.—Formation of Ligament at Egress. The phenomenon was entirely similar to the change from double to single curvature at the ingress, but in reverse order; the time noted was May 6, $4^h\ 30^m\ 58^s$, L.M.T., corresponding to $5^h\ 34^m\ 4^s$, W.M.T.

Phase 7.—Second Internal Contact. I again tried, as in *Phase 3*, to note the instant when the limb of Mercury was in geometric contact with the limb of the sun. This moment was certainly between the cessation of light undulation round the entire planet and the formation of the cusps. The time noted was $4^h\ 31^m\ 5^s$, L.M.T. corresponding to $5^h\ 34^m 11^s$, W.M.T. The light undulation round the planet probably ceased about twelve seconds earlier, or very near the time of *Phase 6.*

Phase 8.—External Contact at Egress. The time of this last of the Phases was noted at $4^h\ 33^m\ 52^s$, L.M.T., corresponding to $5^h\ 36^m\ 58^s$, W.M.T. I regard the time noted for this Phase as well nigh free from all error. The edges of discs were both distinct and steady, far beyond my expectation. The vanishing of the last notch of Mercury was almost as precise as the immersion of a star on the moon's dark limb, and far more precise than its immersion on the bright limb. I can not think there can be an error of more than ± $0^s.5$ in the time of this contact. After the planet had passed entirely off the sun I again made the most earnest effort to detect some trace of it, but without success.

Special Phases.—1. Thirty minutes before the egress there was a diffusion of light, as of glancing rays, which seemed to me to reveal the spherical surface of Mercury as the raised convexity of the moon's bright surface appears, when the terminator is well advanced. I watched it for some minutes with great satisfaction. I can not think that my imagination constructed it from preconceived notions of convexity.

2. At no time during the transit (lasting more than 7½ hours) could I detect any spots of marked brightness on the face of the planet, nor any ring or arc of light. I also directed the attention of visitors to these points, and asked them to scrutinize the disc and border most attentively, to detect them, if possible. As I accommodated more than fifty visitors at the Observatory during the intervals of observation, and none of them detected such special markings, I think the evidence is quite strong against their existence. This, however, I can confidently say, the bluish-black disc of Mercury was not uniformly dark; there was a slightly mottled appearance in several parts, particularly southwest of the center about

3 P.M. In my finder of three inches aperture, and furnished with a shade differing very little from that on the micrometer eye-piece, the image of Mercury appeared during the whole transit surrounded with a ring or halo of light. This was so marked as to attract the attention of visitors. Indeed, my attention was first directed to it by a visitor. This was not a result of focal adjustment, for the finder never showed better images.

3. During the progress of the micrometer measures, on the diameter of the planet, I noticed one phenomenon which seems to me to bear some analogy to the "Ligament" or "Black Drop," as it is frequently called. When the micrometer thread, tipped with sun-light, and sun at a certain angle, was brought near to the planet, there was an apparent protrusion from the planet towards the wire, entirely similar to the ligament, but on a much smaller scale. I am sure of no deception in this matter, for unsolicited and unlooked for it arrested my attention, and I repeated the experiment frequently. It seemed to me that when the image of the planet was made to approach any strongly illuminated edge that this phenomenon immediately manifested itself. An illuminated edge seemed to be essential to it. Remarks on this observation, by Prof. H. M. Paul, may be seen in the *Appendix No. 1, Washington Observations, 1876*, page 116.

MICROMETER MEASURES OF DIAMETER OF MERCURY ON SUN'S DISC.

Mic. I.	Mic. II.	Mic. I.	Mic. II.	Mic. I.	Mic. II.	Mic. I.	Mic. II.
North to South.		East to West.		Northeast to Southwest.		Southeast to Northwest.	
86.430	88.212	86.400	88.235	86.449	88.216	86.436	88.206
.475	.276	.418	.204	.460	.220	.418	.206
.480	.219	.448	.262	.415	.221	.409	.204
.498	.278	.466	.228			.386	.198
				86.441	88.219		
		.480	.228			.395	.180
86.471	88.246			0.8895 Rev. =	11″.49		
0.8875 Rev. =	11″.46	86.442	88.232			86.409	88.199
		0.8950 Rev. =	11″.55	86.454	88.274	0.8950 Rev. =	11″.55
86.450	88.220			.425	.293		
.466	.262	86.464	88.210	.430	.218		
.408	.261	.485	.233				
				86.436	88.262		
.486	.252	.452	.266				
				0.9130 Rev. =	11″.79		
.455	.314	.443	.215				
86.466	88.262	86.462	88.231				
0.8980 Rev. =	11″.59	0.8845 Rev. =	11″.42				
Mean = 11″.525		Mean = 11″.485		Mean = 11″.640		Mean = 11″.550	

The general mean of these observations is 11″.55. The small differences in these series I am sure is not due to any real difference in the apparent diameters. The compression is too small to be detected by such measures. The values here given for the several directions, and for the general mean, differ slightly from those given in *Appendix No. 2, Washington Observations, 1876,* and *Observatory No. 17.* They have been derived from a careful revision of the original records, and the final value of the micrometer screw. The difference between the two general means is 0″.17.

OCCULTATIONS OF STARS BY THE MOON.

For several years after work was begun at the Observatory, some of the brighter stars were observed at occultation, from month to month, as opportunity occurred. The immediate object of these observations was to secure available data for a preliminary determination of the longitude. After a number of fruitless efforts to secure corresponding observations at some fixed observatory, whose longitude was well determined, the observations were discontinued. While looking over the note books, such of these observations as readily presented themselves have been noted, and are here inserted, in the hope that they may be of some use, either in longitude determinations, or in comparing the observed and tabular places of the moon. In several instances the star itself has not been fully identified. Such stars are marked with an asterisk. The time of immersion or emersion was noted by a practiced assistant from the face of sidereal chronometer, Negus 1590, for all the occultations to April 22, 1877. The subsequent ones were noted on the chronograph. In every instance the error of chronometer or clock was carefully ascertained and applied.

Date.	Star.	L. M. Time.	Remarks.
1876.		h. m. s.	
May 26	ω^1 Cancri *	9 38 4.86	Im. Fine Seeing.
May 26	ω^2 Cancri *	9 42 31.63	Im. Fine Seeing.
July 29	*b* Scorpii	7 27 38.77	Im. Fine Seeing.
Aug. 25	Y. 6403 *	7 54 21.79	Im. Mg. 7.3 Good Obs.
Oct. 25*	Prob. Arg. S. Z. P, 333—22, No. 1.	6 43 4.72	Im. Mg. 8, very good
Nov. 25	B. A. C. 8311	11 49 10.88	Im. Obs. satisfactory.
Dec. 4	γ Cancri	9 55 25.89	Im. Duration $9^m.5$. Good.
Dec. 26	μ Arietis.	5 55 17.10	Im. Very satisfactory.
1877.			
Feb. 1	χ Virginis	17 11 0.13	Im. Excellent obs.
Feb. 1	χ Virginis	18 23 13.18	Em. Very good.
Mar. 19	μ Pleiadum	7 59 44.16	Im. very good obs.
Mar. 19	μ Pleiadum	9 5 14.80	Em. Prob. er. $\pm 1^s$.
1877.		h. m. s.	
April 22	45 Leonis	7 33 19.23	Im. Obs. very good.
May 28	B.A.C. 6220*	15 17 33.05	Im. Satisfactory.
July 28	11 Piscium	15 17 1.05	Im. Br. limb. Prob. er. $\pm 2^s$.
Nov. 11	20 Capricorni	9 14 34.57	Im. Very good.
Nov. 12	45 Capricorni	7 53 44.65	Im. Very good.
1878.			
Feb. 5	9897 Schj. *	7 58 44.68	Im. Very good.
April 10	μ^2 Cancri	9 44 12.03	Im. Very good.
Nov. 1	21 Capricor.*	7 56 48.47	Im. Good.
1879.			
June 3	Antares	9 22 27.10	Im. Excellent.
June 3	Antares	10 33 6.12	Em. Good. Prob. er. $\pm 1^s$
Aug. 24	Antares	9 14 27.42	Im. Obs. very good.
Aug. 24	Antares		Time lost on Chrono.

Occultation of a Star by Jupiter. Under the Planet Jupiter, an account is given of the occultation of 4 Geminorum, Greenwich 7 Yr. Cat., No. 788. The star finally disappeared at $11^h\ 28^m\ 56^s.91$, L.M.T., 1882, November 7.

OCCULTATION OF PLANETS.

The Occultation of Uranus, by the moon, was observed 1877, April 21. Moment of first contact, beginning of partial phase, $11^h 27^m 10^s.86$, L.M.T. Moment of internal contact, beginning of total phase, $11^h 27^m 14^s.85$, L.M.T. External contact at emersion (not satisfactory), $12^h 25^m 22.80 \pm 15^s$. The duration of occultation was $49^m 48^s.86$. But the glare of moon's bright limb obscured the planet a few seconds at emersion. Hence the doubt.

Occultation of Venus, 1877, December 8. As this phenomenon was witnessed over all the western part of the United States, and the interest taken in it was shared alike by the educated and illiterate, and even by children, I shall abridge an account of its observation here from an article of a popular cast which I published in the *Kansas City Review*, February, 1878.

The evening was as favorable as possible, the sky being cloudless and temperature agreeable, 37° Fah. in the open air. Many persons noted the time of disappearance of Venus, as seen by the unassisted eye. But in a large telescope there were several phases of great interest. I speak of them as they appeared in the field of such an instrument, under an amplifying power of 275.

The unassisted eye could readily see, beside the bright crescent of the moon, the dark portion of her disc rendered visible by the reflection of light from the earth. On the evening of December 8, Venus was only three days from her greatest eastern elongation; hence her disc was almost perfectly divided into semicircles — one brilliantly lighted by the sun's direct rays, and the other entirely dark; even the feeble ashy light fading out in presence of the moon. For half an hour, Venus, to the unaided eye, seemed to stand still on the northeastern limb of the moon, on the very border of the "ashy light." In the field of the telescope the limbs appeared separated by an interval of several minutes of arc, the bright semicircle of Venus being turned towards the moon's dark limb. The purity and stillness of the air served to show the moon's dark limb to great advantage, the sky beyond appearing black in contrast with the "ashy light." The boundary of the moon's dark limb being thus distinctly marked, I watched eagerly the gradual approach of the bright and ashy discs, holding my finger on the break circuit key, ready to note on the chronograph the instant of contact.

The view was rare and beautiful. In the occultation of the brightest fixed stars, the moon's dark limb approaches only an intensely bright point; but here two great spheres projected as circles were rapidly approaching each other.

When the bright limb of Venus was within 8″ or 10″ of the moon's dark limb, a phenomenon occurred, which has always been noted in a superior degree in the transits of Venus across the sun's disc. Perhaps it may afford some indication of the extent and density of the atmosphere of Venus. Instead of a sharp, closely defined contact of discs, which was so fully promised, a border of wavering light, several seconds in width, seemed to precede the planet. Its general effect was such as to place in slight doubt the moment of external contact. The instant noted for external contact was $5^h\ 36^m\ 55^s.92$, L.M.T. This time, however, must be taken rather as the instant of first appreciable encroachment on the bright limb of the planet, and marking the beginning of partial phase.

FIG. 1.

1877 Dec. 8.

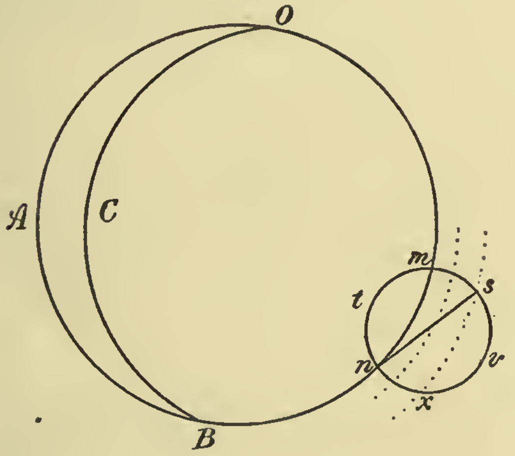
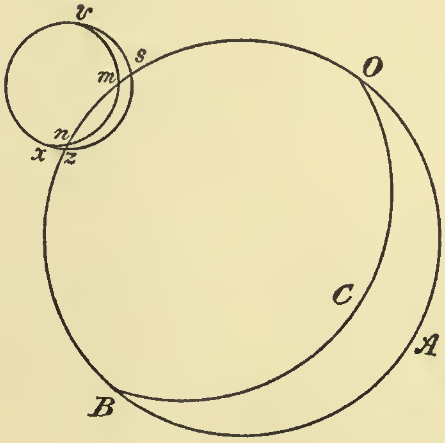


FIG. 2.

1879 Oct. 12.



The curve of the moon's dark limb projected on the bright semi-circle of Venus now rapidly advanced towards the straight line or diameter dividing the enlightened and unenlightened halves. In $31^s.10$ this curve reached the northern cusp of the planet. This cusp was simply blunted, but there was no disturbing arc of light, and the time was instantaneously noted at $5^h 37^m 26^s.94$, L.M.T. Now began the most interesting part of the phenomenon. It consisted in the constant cutting away of the sector-like surface formed by the straight terminator of Venus, the curve of the moon's limb, and the rim of Venus. The figure annexed (Fig. 1) shows the sector as bounded by the straight line *n s*, the curve *n m*, and the curve *m s*. As drawn, the curve of the moon's dark limb has just reached the northern cusp; the two dotted arcs are intended to represent the advancing curve of the moon's dark limb near the middle of the sector, and when the southern cusp was reached, and the planet was totally concealed. Since in a large instrument, even with a moderate power, only a small portion of the moon's surface can be seen, while the whole visible surface of Venus occupies a conspicuous part of the field, there is no way to secure the just optical effect, but by drawing Venus with an apparent diameter far greater than is due. Bearing in mind the *intentional* disproportion of the disks, the lune $O\,A\,B\,C\,O$ represents the enlightened part of the moon, the semi-circle $n\,x\,v\,s$, the dark part of Venus, the figure $n\,t\,m\,n$, the part of Venus occulted when the northern cusp was reached, and the sector $n\,m\,s\,n$, the part still enlightened.

After the immersion of the northern cusp only about 20^s remained till the occultation was complete. These were moments of intense interest, as I watched the advancing arc cutting off more and more of the small triangular patch of light, and saw it gradually fading into nothingness. In a few seconds the southern cusp shot out its last ray — Hesperus had disappeared from the sky, Cynthia had vanquished Venus. The total immersion occurred at $5^h\ 37^m\ 45^s.96$, L.M.T. At this time, however, all that part of Venus bounded by the curves $x\,s$ and $x\,v\,s$ was projected still beyond the moon's dark limb.

In the emersion first came the internal contact of discs, which marks the close of the total phase. Occurring on the moon's bright limb the time of its occurrence, or rather the instant of first light from the emerging rim of Venus, could not be sharply noted. The emergence of the northern cusp was noted sharply at $6^h\ 46^m\ 44^s.19$, L.M.T. The duration of the phenomenon from first contact to the emersion of the northern cusp being $1^h\ 9^m\ 48^s.27$. Only a few seconds later, and the entire dark semi-circle of the planet emerged from behind the moon's bright limb; the bounding rim of Venus on the dark limb being invisible, it was impossible to note the exact time.

Partial Occultation of Venus by the Moon, October 12, 1879. To the unaided eye the light of Venus, in this occultation, was only perceptibly diminished; but the very interesting phases presented in the telescope were wholly concealed from unassisted vision. The phase at greatest obscuration possesses a very unique interest, on account of the peculiar relation of the bounding curves of light and darkness.

The morning was very fine, one of the most beautiful known to our climate. Not a cloud or vapor disturbed the observation. The image of Venus, usually so wavering, was very steady. I never before saw the planet so beautiful. At $20^h\ 55^m$ L.M.T., the following measures of position angle and distance of cusps were made —

$$p = 208^\circ.58 \qquad\qquad s = 50''.6$$

The planet was moving northward at the rate of 34″ per hour. Its easterly motion was very small (Venus being nearly stationary at that time), less than 4″

per hour. The moon was moving southward at the rate of 15″.3 per minute, and eastward at the rate of 31″.5 per minute. For some time it seemed that the moon would pass Venus from northwest to southeast, without any encroachment whatever, on the disc of the planet. At 20^h 55^m 15^s, L.M.T., and while the adjacent dark limb of the moon was entirely invisible, that peculiar bluish or purplish light, which heralds the approach of the moon into the field of a telescope, began to manifest itself. The immediate effect was to render much darker the hollow cavity between the cusps of Venus, and to blunt both cusps. This decided change was so remarkable as to engross my whole attention. It seemed as if a segment much darker than the unillumined part of Venus between the cusps, had been suddenly protruded into the space between the horns. Even the southwestern horn of Venus, which at no time was occulted, was for some moments sensibly blunted. As we have no evidence of a lunar atmosphere, these effects are probably due to irradiation. Perhaps the dense atmosphere of Venus herself may in part account for it.

As the dark limb of the moon moved for some minutes in contact with the northeastern cusp of Venus, it was very difficult to note the exact second when the encroachment began. At 20^h 55^m 30^s, L.M.T., the moon's dark limb was certainly beginning to cut into the narrow crescent of Venus, and this must stand for the beginning of the phase. At 20^h 55^m 50^s a very sensible point had been cut off from the northeastern horn. At 21^h 1^m 56^s the greatest phase was manifested, when more than one-half of the bright crescent of Venus had been cut away. It was a most unique and beautiful sight to behold that sharp, slender and bright cusp of the crescent (only 7″.8 in width at its widest part) standing out in the blue sky beyond the moon's dark limb, as if totally separated from the moon and from Venus. There it stood a quivering bright bird-beak cusp, with the moon's dark limb cutting down obliquely through its base, and totally isolating it (in appearance) from everything else in nature. An idea of its appearance may be formed by referring to the cusp $m\ s\ v$, Fig. 2, and remembering that it is the only luminous surface in the field of vision. Near this time, the chord joining the S.W. horn of Venus to the internal point of the crescent, cut by the moon's dark limb, was measured and found to be 37″.43. At 21^h 4^m 13^s another measure of this continually increasing chord and its position angle was made, the result standing $p = 221°$, $s = 49''.06$. Hardly had this measure been completed when the northern horn flashed out into view from behind the moon's dark limb like a bright star. This occurred at 21^h 7^m 21^s. Both horns of Venus were now projected beyond the moon's dark limb. Fig. 2 is designed to represent this phase a few seconds after the northern horn, $x\ z\ n$, had flashed out into view. A thin lunar segment still concealed a corresponding segment of Venus; but in a few seconds a narrow thread of light broke through, and the perfect crescent shone in its wonted splendor. As the edge of the crescent, near the point of external contact, came into view, the inequalities on the moon's surface gave the edge of the crescent a very notched appearance. Duration of the phase, $11^m\ 41^s$.

DIAMETERS OF MARS.

Reduction of Observations of Diameters of Mars, made at the opposition of 1881–82. At the oppositions of Mars in 1879–80, and in 1881–82, series of measures of his apparent diameters were made by myself with the large filar micrometer of our equatorial. The former series was reduced by Prof. Henry S. Pritchett, and the results are given in *Astronomische Nachrichten*, 2309. The later series I have now reduced, and the observations and reductions appear here, in detail; and the results are compared with those of the former series. An abridgment, showing results, appears in *Astronomische Nachrichten*, 2652. The correction for phase was computed from the difference formula, $\Delta s = \frac{4}{3} \cdot \frac{q}{\pi} \sin (p - \theta)$, in which q is the greatest defect of illumination, and p and θ are position angles of points on the defective limb, and of the line joining the cusps. The directions of the observed diameters are for the equator of Mars—Equator + 45°, the poles and poles + 45° — the angles being reckoned, as usual, from the north by way of the east. The values of q and θ, and the direction of the axis of Mars, have been taken on the authority of Mr. A. Marth (*Monthly Notices*, Vol. XXXIX.). In the following table the approximate mean time of observation is given for the local meridian in column 1, the approximate hour angle in column 2, the direction in column 3, the observed value (O.V.) in column 4, number of observations in column 5, correction for phase in column 6, the corrected diameter in column 7, and the diameter, at distance unity, in column 8. In reducing to distance unity, the distances between the centers of the earth and Mars were carefully interpolated from the *British Nautical Almanac*.

C. W. PRITCHETT.

Date.		M. T. M. O.	H. A.	Direction.	O. V.	No. Obs.	Phase.	Cor. Dia.	Dia. at 1.
		h. m.	h.	° °	"		"	"	"
1881, Dec.	4	10 47.5	—3.24	71–251	15.08	3	+0.16	15.24	9.613
"	4	57.0	—3.08	116–296	14.42	3	0.15	14.57	9.190
"	4	11 4.0	—2.97	161–341	14.20	3	0.06	14.26	8.995
"	6	10 44.5	—3.12	71–251	15.49	3	0.13	15.62	9.758
"	6	54.5	—2.96	116–296	14.68	3	0.13	14.81	9.252
"	6	11 5.0	—2.78	161–341	14.73	3	0.05	14.78	9.233
"	8	18 6.5	+4.41	70–250	14.58	3	0.11	14.69	9.087*
"	13	17 53.5	+4.64	70–250	16.48	3	0.06	16.54	10.066
"	13	18 4.0	4.82	115–295	15.44	3	0.06	15.50	9.433
"	13	13.0	4.97	160–340	16.07	4	0.02	16.09	9.791
"	14	9 36.0	—3.56	69–249	16.18	4	0.06	16.24	9.868
"	14	49.5	—3.33	114–294	15.45	4	0.06	15.41	9.363
"	14	57.0	—3.04	159–339	15.52	4	0.03	15.55	9.448
"	15	11 47.0	—1.28	69–249	15.37	4	0.04	15.41	9.342
"	15	52.5	—1.20	114–294	15.32	4	0.04	15.36	9.311
"	15	58.0	—1.10	159–339	15.00	4	0.01	15.01	9.099
"	16	8 41.5	—4.28	69–249	15.78	4	0.04	15.81	9.569
"	16	45.0	—4.22	114–294	15.57	4	0.04	15.61	9.448
"	16	9 7.5	—3.85	159–339	14.88	4	0.01	14.89	9.012
"	16	19.5	—3.65	204– 24	15.66	4	0.02	15.68	9.490
"	21	9 58.0	—2.54	68–248	15.93	4	0.01	15.94	9.608
"	21	10 5.5	—2.42	113–293	15.44	4	0.01	15.45	9.312
"	21	13.5	—2 28	158–338	15.14	4	0.00	15.14	9.127
"	21	22.0	—2.14	203– 23	15.67	4	0.01	15.68	9.452
"	22	16 41.5	+4.28	68–248	15.34	4	0.01	15.35	9.257
"	22	48.5	4.39	113–293	15.42	4	0.01	15.43	9.305
"	22	56.0	4.52	158–338	15.48	4	0.00	15.48	9.335
"	22	17 1.5	4.61	203– 23	15.27	4	0.01	15.28	9.215
"	23	9 14.0	—3.08	67–247	15.63	4	0.01	15.64	9.437
"	23	24.0	—2.92	112–292	15.41	4	0.01	15.42	9.303
"	23	36.0	—2.72	157–337	15.32	4	0.00	15.32	9.244
"	23	41.0	—2.63	202– 22	15.49	4	0.01	15.50	9.352
"	24	9 22.5	—2.85	67–247	16.01	4	0.01	16.02	9.675
"	24	28.0	—2.76	112–292	14.94	4	0.00	14.94	9.023
"	24	34.0	—2.66	157–337	15.46	4	0.00	15.46	9.337
"	24	38.5	—2.58	202– 22	15.86	4	0.01	15.87	9.585
"	25	10 14.0	—1.90	67–247	16.07	4	0.00	16.07	9.719
"	25	20.5	—1.79	112–292	15.54	4	0.00	15.54	9.399
"	25	27.5	—1.67	157–337	15.54	4	0.00	15.54	9.399
"	25	34.5	—1.55	202– 22	15.78	4	0.01	15.78	9.544
"	26	9 16.5	—2.76	67–247	15.22	4	0.01	15.23	9.227
"	26	26.0	—2.60	112–292	15.33	4	0.00	15.33	9.287
"	26	33.0	—2.48	157–337	15.71	4	0.00	15.71	9.517
"	26	38.0	—2.40	202– 22	15.49	4	0.01	15.50	9.390
"	28	8 41.5	—3.15	66–246	15.85	4	0.00	15.85	9.644
"	28	46.5	—3.07	111–291	15.39	4	0.01	15.40	9.370
"	28	52.5	—2.97	156–336	15.13	4	0.01	15.14	9.212
"	28	57.5	—2.89	201– 21	15.55	4	0.00	15.55	9.462
1882, Jan.	6	7 22.5	—3.36	65–245	15.00	4	0.04	15.04	9.489
"	6	34.0	—3.44	110–290	14.34	4	0.05	14.39	9.080
"	6	46.5	—3.21	155–335	14.39	4	0.03	14.42	9.099
"	6	8 2.5	—2.97	200– 20	14.67	4	0.00	14.67	9.258
"	8	7 50.5	—2.99	64–244	14.76	4	0.04	14.80	9.447
"	8	8 3.0	—2.78	109–289	14.59	4	0.05	14.64	9.345
"	8	26.5	—2.39	154–334	14.67	4	0.03	14.70	9.385
"	8	38.5	—2.19	199– 19	14.21	4	+0.01	14.22	9.079

* Rejected.

Date.	M. T. M. O.	H. A.	Direction.	O. V.	No. Obs.	Phase.	Cor. Dia.	Dia. at 1.
	h. m.	h.	° °	"		"	"	"
1882, Jan. 11	7 22.5	—3.19	64–244	14.26	4	+0.08	14.34	9.330
" 11	32.5	—3.02	109–289	13.78	4	0.08	13.86	9.018
" 11	42.5	—2.86	154–334	13.77	4	0.04	13.81	8.991
" 11	51.5	—2.71	199– 19	14.68	4	0.02	14.70	9.565
" 13	8 13.0	—2.18	64–244	14.25	4	0.07	14.32	9 451
" 13	21.5	—2.02	109–289	14.00	4	0.10	14.10	9.306
" 13	36.5	—1.79	154–334	13.78	4	0.07	13.85	9.141
" 13	50.0	—1.56	199– 19	13.89	4	0.02	13.91	9.182
" 14	8 10.5	—2.13	64–244	14.26	4	0.09	14.35	9.541
" 14	16.5	—2.04	109–289	14.29	4	0.11	14.40	9.575
" 14	22.5	—1.94	154–334	14.04	4	0.06	14.30	9.509
" 14	28.0	—1.84	199– 19	14.12	4	0.02	14.14	9.402
" 17	7 23.0	—2.68	63–243	13.71	4	0.11	13.83	9.410
" 17	30.0	—2.56	108–288	12.91	4	0.12	13.21	8.990
" 17	37.0	—2.45	153–333	13.53	4	0.07	13.60	9.254
" 17	42.0	—2.36	198– 18	13.42	4	0.03	13 45	9.152
" 18	7 22.5	—2.61	63–243	13.72	4	0.12	13.84	9.495
" 18	27.5	—2.52	108–288	13.16	4	0.14	13.30	9.124
" 18	33.5	—2.42	153–333	13.38	4	0.08	13.46	9.234
" 18	39.5	—2.32	198– 18	13.59	4	0.03	13.62	9.344
" 21	7 14.8	—2.50	63–243	13.42	4	0.15	13.57	9.548
" 21	20.5	—2.41	108–288	13.30	4	0.16	13.46	9.471
" 21	26.2	—2.31	153–333	13.30	4	0.09	13.39	9.423
" 21	31.9	—2.21	198– 18	13.36	4	0.04	13.40	9.429
" 22	6 50.5	—2.82	63–243	13.68	4	0.15	13.63	9.673
" 22	59.5	—2.68	108–288	13.12	4	0.17	13.29	9.433
" 22	7 9.0	—2.52	153–333	13.16	4	0.09	13.25	9.404
" 22	18.5	—2.36	198– 18	13.23	4	0.04	13.27	9.420
" 26	6 55.6	—2.44	63–243	13.39	4	0.19	13.58	9.995
" 26	7 6.8	—2.26	108–288	13.42	4	0.21	13.63	10.032
" 26	18.0	—2.07	153–333	12.91	4	0.10	13.01	9.576
" 26	29.3	—1.89	198– 18	12.52	4	0.06	12.58	9.261
" 28	7 8.5	—2.09	63–243	13.05	4	0.22	13.27	9.953
" 28	15.5	—1.97	108–288	13.08	4	0.22	13.30	9.975
" 28	22.5	—1.86	153–333	13.47	4	0.11	13.58	10.184
" 28	29.5	—1.74	198– 18	12.99	4	0.06	13.05	9.788
" 31	7 22.6	—1.65	62–242	12.71	4	0.22	12.93	9.979
" 31	27.8	—1.56	107–287	12.36	4	0.24	12.60	9.725
" 31	33.0	—0.48	152–332	12.48	4	0.13	12.61	9.733
" 31	43.4	—1.30	197– 17	13.23	4	0.06	13.29	9.259
1882, Feb. 2	7 11.5	—1.70	62–242	12.43	4	0.23	12.66	9.661
" 2	16.5	—1.62	107–287	11.96	4	0.25	12.21	9.607
" 2	21.5	—1.54	152–332	12.09	4	0.13	12.22	9.616
" 2	31.5	—1.37	197– 17	12.30	4	0.07	12.37	9.734
" 4	7 32.5	—1.22	62–242	12.28	4	0.24	12.52	10.047
" 4	37.5	—1.14	107–287	11.99	4	0.27	12.26	9.839
" 4	42.5	—1.06	152–332	12.41	4	0.14	12.55	10.072
" 4	47.5	—0.98	197– 17	11.94	4	0.07	12.01	9.639
" 7	7 43.0	—0.86	63–243	12.05	4	0.26	12.31	10.175
" 7	49.0	—0.76	108–288	11.50	4	0.28	11.78	9.737
" 7	55.0	—0.66	153–333	11.46	4	0.13	11.59	9.581
" 7	8 7.0	—0.46	198– 18	12.30	4	0.09	12.39	10.243
" 8	9 55.3	+1.40	63–243	11.14	4	0.26	11.40	9.524
" 8	59.9	1.48	108–288	11.48	4	0.28	11.76	9.825
" 8	10 4.5	1.55	153–333	11.83	4	0.15	11.98	10.010
" 8	13.7	1.71	198– 18	11.11	4	+0.09	11.20	9.358

Date.	M. T. M. O.	H. A.	Direction.	O. V.	No. Obs.	Phase.	Cor. Dia.	Dia. at 1.
	h. m.	h.	° °	″		″	″	″
1882, Feb. 9	9 29.9	+1.03	63–243	10.78	4	+0.27	11.05	9.321
“ 9	35.7	1.13	108–288	10.88	4	0.29	11.17	9.424
“ 9	41.5	1.23	153–333	10.68	4	0.14	10.82	9.129
“ 9	53.1	1.42	198– 18	10.81	4	0.09	10.90	9.197
“ 13	7 25.8	—0.80	63–243	11.07	4	0.28	11.35	9.952
“ 13	31.4	0.71	108–288	10.49	4	0.30	10.79	9.461
“ 13	37.0	0.61	153–333	10.37	4	0.15	10.52	9.225
“ 13	48.2	—0.43	198– 18	10.67	4	0.09	10.76	9.437
1882, Feb. 14	9 13.3	+1.04	63–243	10.29	4	0 28	10.57	9.365
“ 14	19.9	1.15	108–288	10.67	4	0.31	10.97	9.720
“ 14	26.5	1.27	153–333	10.56	4	0.15	10.71	9.489
“ 14	9 39.7	+1.48	198– 18	10.04	4	+0.09	10.13	8.976

TABULATION OF RESULTS, AND RESIDUALS WITH THEIR SQUARES.

Date.	Equator.	Eq. +45°	Poles	Poles +45°	EQUATOR.		Eq. +45°		Poles.		Poles +45°	
					v	vv	v	vv	v	vv	v	vv
1881.	″	″	″	″	″	″	″	″	″	″	″	″
Dec. 4	9.613	9.190	8.995		+0.02	0.0004	+0.24	0.0576	+0.40	0.1600		
“ 6	9.758	9.252	9.233		—0.12	0.0144	+0.18	0.0324	+0.17	0.0289		
“ 13	10.066	9.433	9.791		—0.43	0.1849	0.00	0.0000	—0.39	0.1521		
“ 14	9.868	9.363	9.448		—0.23	0.0529	+0.06	0.0036	—0.05	0.0025		
“ 15	9.342	9.311	9.099		+0.30	0.0900	+0.12	0.0144	+0.30	0.0900		
“ 16	9.569	9.448	9.012	9.490	+0.07	0.0049	—0.02	0.0004	+0.39	0.1521	—0.04	0.0016
“ 21	9.608	9.312	9.127	9.452	+0.03	0.0009	+0.12	0.0144	+0.27	0.0729	0.00	0.0000
“ 22	9.257	9.305	9.335	9.215	+0.38	0.1444	+0.12	0.0144	+0.06	0.0036	+0.24	0.0576
“ 23	9.437	9.303	9.244	9.352	+0.20	0.0400	+0.12	0.0144	+0.16	0.0256	+0.10	0.0100
“ 24	9.675	9.023	9.337	9.585	—0.04	0.0016	+0.40	0.1600	+0.06	0.0036	—0.13	0.0169
“ 25	9.719	9.399	9.399	9.544	—0.08	0.0064	+0.03	0.0009	0.00	0.0000	—0.09	0.0081
“ 26	9.227	9.287	9.517	9.390	+0.41	0.1681	+0.14	0.0196	—0.12	0.0144	—0.06	0.0036
“ 28	9.614	9.370	9.212	9.462	—0.01	0.0001	+0.06	0.0036	+0.19	0.0361	—0.01	0.0001
1882.												
Jan. 6	9.489	9.080	9.099	9.258	+0.15	0.0225	+0.35	0.1225	+0.30	0.0900	+0.19	0.0361
“ 8	9.447	9.345	9.385	9.079	+0.19	0.0361	+0.08	0.0064	+0.01	0.0001	+0.37	0.1369
“ 11	9.330	9.018	8.991	9.565	+0.31	0.0961	+0.41	0.1681	+0.41	0.1681	—0.11	0.0121
“ 13	9.451	9.306	9.141	9.182	—0.19	0.0361	+0.12	0.0144	+0.26	0.0676	+0 27	0.0729
“ 14	9.541	9.575	9.509	9.402	—0.10	0.0100	—0.15	0.0225	—0.11	0.0121	+0.05	0.0025
“ 17	9.410	8.990	9.254	9.152	+0.23	0.0529	+0.44	0.1936	+0.15	0.0225	+0.30	0.0900
“ 18	9.495	9.124	9.234	9.344	+0.14	0.0196	+0.30	0.0900	+0.17	0.0289	+0.11	0.0121
“ 21	9.548	9.471	9.423	9.429	—0.09	0.0081	—0.04	0.0016	—0.02	0.0004	—0.02	0.0004
“ 22	9.673	9.433	9.404	9.420	—0.04	0.0016	0.00	0.0000	0.00	0.0000	+0.03	0.0009
“ 26	9.995	10.032	9.576	9.261	—0.36	0.1296	—0.60	0.3600	—0.18	0.0324	+0.19	0.0361
“ 28	9.953	9.975	10.184	9.788	—0.32	0.1024	—0.55	0.3025	—0.78	0.6084	—0.34	0.1156
“ 31	9.979	9.725	9.733	10.259	—0.34	0.1156	—0.30	0.0900	—0.33	0.1089	—0.81	0.6561
Feb. 2	9.961	9.607	9.616	9.734	—0.32	0.1024	—0.18	0.0324	—0.22	0.0484	—0.28	0.0784
“ 4	10.047	9.839	10.072	9.639	—0.41	0.1681	—0.41	0.1681	—0.67	0.4489	—0.19	0.0361
“ 7	10.175	9.737	9.581	10.243	—0.54	0 2916	—0.31	0.0961	—0.18	0.0324	—0.79	0.6241
“ 8	9.524	9.825	10.010	9.358	+0.11	0.0121	—0.40	0.1600	—0.61	0.3721	+0.09	0.0081
“ 9	9.321	9.424	9.129	9.197	+0.32	0.1024	0.00	0.0000	+0.27	0.0729	+0,25	0.0625
“ 13	9.952	9.461	9.225	9.437	—0.31	0.0961	—0.03	0.0009	+0.17	0.0289	+0.01	0.0001
“ 14	9,365	9.720	9.489	8.976	+0.27	0.0729	—0.29	0.0841	—0.09	0.0081	—0.48	0.2304

MEAN RESULTS AND PROBABLE ERRORS.

SERIES OF 1881-82.

Directions.	Diameter.	No. Groups.	Prob. Errors.
	″		
Equator	9.638	32	±0.0316
Equator + 45°	9.428	32	±0.0321
Poles	9.400	32	±0.0365
Poles + 45°	9.452	27	±0.0387

SERIES OF 1879-80.

Directions.	Diameter.	No. Groups.	Prob. Errors.
	″		″
Equator	9.638	17	±0.044
Equator + 45°	9.517	8	±0.032
Poles	9.422	17	±0.024
Poles + 45°	9.489	9	±0.043

Assuming that each observation is an independent measure of the same physical quantity (or neglecting the ellipticity of the disc), and determining the weights from the probable errors, we have

General Mean for 1881–82 = 9″.4835 ± 0″.036. General Mean for 1879–80 = 9″.486 ± 0″.033.

While both series point very decidedly to an elliptical disc, I should be very far from attempting to estimate the compression from these measures. It is worthy of notice that the general mean of the two series is not very far from the arithmetic mean between Dr. Hartwig's value from heliometer measures, 9″.352 (*Pub. Ast. Ges.*, XV.), and the value 9″.697 deduced by Mr. A. M. H. Downing from 537 observations of the vertical diameter, made with the Greenwich Transit Circle between the years 1851–1880. See *Monthly Notices*, Vol. XLII.

THE PLANET JUPITER.

For two hundred and fifty years past, observations on this gigantic planet have been first in order, with all who possessed the means of making them. His broad and variegated disc, his great belt system, and his ever-changing satellites, have been observed and drawn thousands of times, and yet the attraction is ever new and resistless for every amateur. During the last seven years, observations on Jovian phenomena have been greatly stimulated by the appearance and persistence of the "Great Red Spot," which came under observation in July, 1878. Some astronomers have taken considerable pains in looking up evidence for its previous existence, and for its periodical returns. There is indeed no trouble to refer to previous markings, which resemble more or less strikingly in form and color, this spot; but all the evidence connecting them with the "Great Red Spot," is almost fatally impaired by the rapid drift of nearly all spots on the Jovian surface. The red spot has been comparatively stable; yet, even this great landmark has so retrograded that the axial rotation of the planet, as determined from it, differs nearly five seconds of time between 1878–79 and 1884–85. All who have taken the pains to compare for themselves its position at various dates relatively to Mr. Marth's zero meridian, must be satisfied, either that the spot, stable as it has seemed, has actually drifted in the Jovian atmosphere, or if solid land, as some maintain, that the elliptical aperture in the cloudy covering has drifted and exposed different parts of the red-hot surface of the planet. Be this as it may, the first observation of this most striking marking obtained in the northern hemisphere was made at the MORRISON OBSERVATORY, July 9, 1878. An account of the observation, together with a sketch, is published in the "*Observatory*" for January, 1879 (No. 21). During the intervening years, not only this spot but various other markings on the surface of Jupiter have been studied with a zeal and painstaking carefulness before unknown. The results have added much to our knowledge of the physical characteristics of the planet, and of the varied and astonishing changes which so frequently occur on the surface; and if they have not fixed the period of axial rotation with absolute certainty, they have at least diminished greatly its limits of error. Should the rotation period ever be absolutely determined, it is not probable that it will differ five seconds from the mean of all the determinations from the red spot.

The observations accumulated in the last seven years, make it evident that the surface and environment of the great planet, are in a state analogous in some respects to those of the sun. It has been known since the investigations of Carrington, that there is a slight difference in the rotation period of the sun, when determined by markings on his equator, and by those considerably north or south of it. Not until late years, however, has it been certainly known of Jupiter, that his mean period of axial rotation differs considerably when determined by spots of different colors, even in the same zone, and especially by spots having different positions relatively to his equator. Spots and markings have abounded during the last few years, and the rotation period has been determined from them over and over again. The results obtained from the observations of the red spot in 1879–80, revealed the fact that it was retarded on the previously accepted time of rotation. The time of rotation, deduced from observations made by the Director of MORRISON OBSERVATORY in 1879–80, may be seen at large in a paper prepared by Mr. Henry S. Pritchett, and read before the Boston meeting of the American Association for the Advancement of Science, held in August, 1880. These observations extend from July 10 to February 5, including 507 rotations of the planet. After correction for aberration, and the relative motion of the earth and Jupiter, equations of condition were formed from the observations, which, solved by the method of least squares, gave the rotation period, $9^h\ 55^m\ 34^s.2 \pm 0^s.7$ (*Proceedings, A. A. for A. S.*, Vol. XXIX., Part I.). For the same opposition, Mr. H. Pratt, of Brighton, England, obtained the value $9^h\ 55^m\ 33^s.91$ from 321 rotations (*Monthly Notices*, Vol. XL.); and Mr. T. D. Brewin, of Leicester, England, the value $9^h\ 55^m\ 34^s.1$ from 437 rotations (*Monthly Notices*, Vol. XL.); while Mr. A. Marth deduced from all the observations of 1879–81, the value $9^h\ 55^m\ 34^s.47$ (*Monthly Notices*, Vol. XLI.). A lengthy discussion of observations, by the late Dr. Julius Schmidt, of the Observatory at Athens, Greece, may be seen in the *Astronomische Nachrichten*, No. 2342. He examines the results from numerous groupings of the observations. The values derived are confined within the limits $9^h\ 55^m\ 31^s$, and $9^h\ 55^m\ 39^s$; but the preponderating value is $9^h\ 55^m\ 34^s.4$, with an outstanding irregularity for the month of September, 1879.

During the years intervening from 1878 to 1884–5, the retardation of the red spot continued, so that the period of rotation for the oppositions of 1882–83, and of 1883–84, as deduced by Prof. Hough of the Dearborne Observatory, Chicago, and by Mr. W. F. Denning of Bristol, England, appear as follows (*Observatory*, No. 95):

HOUGH.		DENNING.	
1882–83	$9^h\ 55^m\ 38^s.4$	1882–83	$9^h\ 55^m\ 39^s.1$
1883–84	$9^h\ 55^m\ 38^s.5$	1883–84	$9^h\ 55^m\ 39^s.1$

The observations of Prof. Hough were made with the 18½-inch refractor, and those of Mr. Denning with a 10-inch reflector. From the observations of these oppositions, Mr. Denning concludes that the retrogradation has ceased; but from some observations, made late in May, 1885, I think, it is yet doubtful.

During the years 1884–85, the red spot lost considerably in redness, especially in the central regions. On the best nights it now shows (June, 1885), an interior white oval, surrounded by an elliptic ring of pale red, sometimes very dull red, and then again the color seems to brighten to a pink tint. But it preserves its distinct outline and environment almost unchanged. It seems to have formed for itself a peculiar recess or shoulder on the south side of the south equatorial belt. Into this curving recess it fits, and has fitted for years past. It is surrounded by a very fine white border, which completely isolates it from the belts both south and north of it. On the south side of it there is a narrow and very variable belt, which sometimes assumes a hue almost blue, or between blue and black. This belt approaches the spot so closely, that some experienced observers in 1884 reported the spot as joined to the belt. I can well conceive, that with low powers or with small

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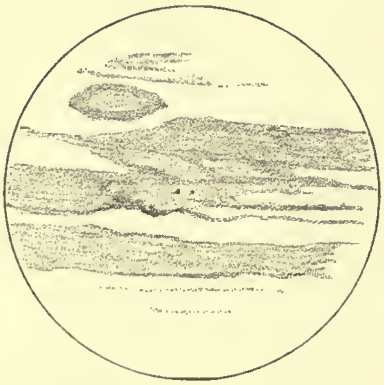
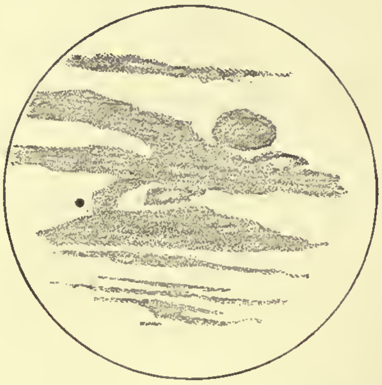


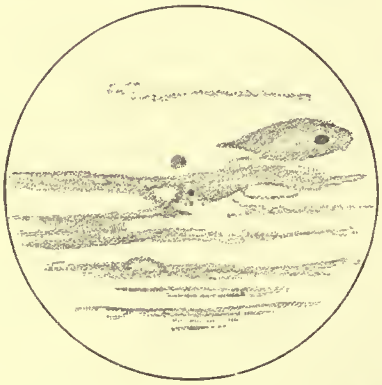
1885, May 3. 8h. 10m., Loc. M.T.

I.



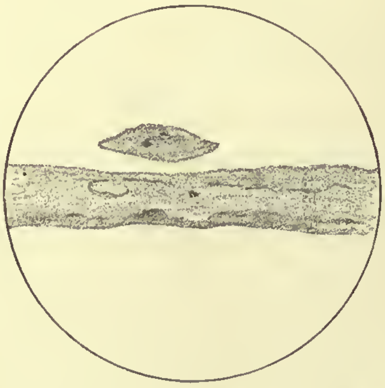
1878, July 9. 12h. 18m., Loc. M.T.

II.



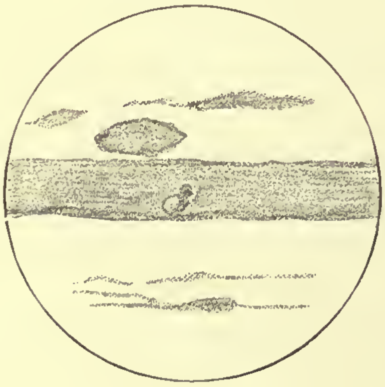
1881, October 3. 14h. 40m., Loc. M.T.

III.



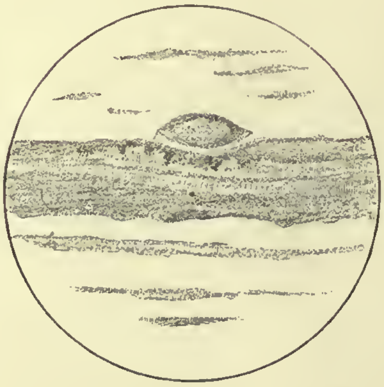
1880, July 10. 14h. 55m., Loc. M.T.

IV.



1880, October 1. 8h. 40m., Loc. M.T.

V.



1885, May 10. 8h. 00m., Loc. M.T.

VI.

JUPITER.

instruments, even in a good atmosphere, an observer should reach this conclusion. In April and May, 1885, the atmospheric conditions being very favorable, I made a special study of this spot relative to its connection with the contiguous belts. With a power of 275, on every occasion, a clear white border could be seen running entirely round it; but this border is perceptibly narrower on the south, than on the north side. On May 3, after satisfying myself fully on this point, I requested my son, C. W. Pritchett, Jr. (who has had much experience in observing), to scrutinize the environment closely. He did so, and at my request, made the drawing No. 1. He was very positive as to the total separation of the spot from the belts. At the same time he recognized the interior white oval, and the darkening at the extreme following end. The drawing, No. 2, is a reproduction of that published in the *Observatory* for January, 1879; and shows the spot and belt system as they appeared July 9, 1878. The changes in the belt system, and the comparative constancy of the spot, are shown by an inspection of these simple sketches, better than by any description. Sketch No. 3 is for October 3, 1881. It exhibits not only the belt system and spot, but Satellite I., and its shadow in transit. It also shows the needle-like projection, to the preceding end of spot, which has so often been observed. It will be noted that the shadow of the satellite is projected on the red spot. Similar projections have been noted several times. Some astronomers insist that there is quite a difference in the darkness of the shadow when projected on the spot, and on the zones of the planet; but I have watched them closely, and frequently, without being able to detect it, even when looking expressly for it. Sketch No. 4 is for July 10, 1880. The shadow of II. is near the preceding end of red spot. The drawing exhibits an unusual structure of the belts. The note book says, "There seems a remarkable absence of belts in northern and southern hemispheres. The surface there seems more luminous than usual; while one notable white spot exists in equatorial belt directly north of preceding end of red spot. There is a trough-like appearance between the belts reaching to the eastern limb. The margin of northern and southern limits of belts is very even and dark; the southern limit has a tinge of blue. The shoulder or recess near following end of red spot almost obliterated." Sketch No. 5 shows the appearance of the belt system, 1880, October 1. The definition was exceedingly fine. The note book says "The belts are densely massed together, and very brown. The trough between the two main equatorial belts filled with loose gray matter. A peculiar cusp-like ridge curves northward from near the following end of red spot. The upper end gathers into a black knot like the shadow of a satellite, but smaller. Then a gray ridge-like shape passes down across the belts, as if a mountain chain branched off from a black peak." Sketch No. 6 is for 1885, May 10, and is intended to show (in contrast with 4 and 5) how numerous the belts become on some fine nights.

These few sketches have been selected from a great multitude. Some of the minor changes and omissions which they reveal are doubtless due to the atmospheric conditions under which we see the planet; but the more noteworthy are indications of the astonishing changes which take place on Jupiter himself.

Dimensions of the Red Spot. Micrometer measures of the dimensions of the red spot have been often made at this Observatory. A mean of those made for the years 1879–80, gives for the major axis 13″.6, and for the minor 3″.98. For several years these measures were repeated very frequently. Before using measures of different dates in discussions relative to the constancy of the spot and the persistence of its dimensions, we must remember that the apparent diameter of Jupiter is about 10″ greater at his perigee than at his apogee; and therefore angular measures of the spot made at different distances must be reduced to a common unit of distance — say the mean distance, which is about 5.01. At the mean distance 1″ subtends at the center of the Jovian surface, about 2500 miles. The "Great Red Spot" therefore extends in length about 33,000 miles, and in width more than 8500 miles, and its surface bears to the entire surface of our globe about the ratio of 27 : 20.

Transit of Spots across the Jovian Disc. The method of observing the transit of the red spot across the central meridian of Jupiter, as practiced at the MORRISON OBSERVATORY, is described in the *Astronomische Nachrichten*, No. 2294. The observations are much facilitated by the peculiar construction of our large filar micrometer (*Vid. Description of Instruments*). The transverse thread is first placed parallel to the Jovian equator, and then one fixed perpendicular thread is placed tangent to one end of the spot, and the movable perpendicular thread is made tangent at the other end. By means of the driving clock, supplemented by a tangent screw, these threads are kept on these ends, and the following times noted. The times in every instance are the means of several estimates.

1. When the thread on end *a* bisects the disc.
2. When the threads make equal segments to right and left of disc.
3. When the thread on end *b* bisects the disc.

The mean of the times for 1 and 3 rarely differs more than one minute from the time of 2. The time noted for 1 is that for transit of central meridian by preceding end; that of 2 is the transit of the center of red spot, and that of 3 is the transit of the following end.

By this method, extensive series of observations were made here during the years 1879–80–81–82. As these series were published from time to time in the different volumes of the *Observatory*, and of the *Monthly Notices* of the Royal Astronomical Society, they will not appear in the present publication. A few observations made in the latter part of 1882, and some made late in the spring of 1885, are here set down, since they have not yet been published. In 1883–84, I made only occasional observations of the red spot. There were several reasons for this. 1. I was fully occupied in other work. 2. The seeing for the greater part of both oppositions was very poor. 3. There was a number of other observers.

TIMES OF TRANSIT.

Date.	G. M. T. Preceding End.	G. M. T. Middle.	G. M. T. Following End.
	h. m.	h. m.	h. m.
1882, Aug. 15		23 26.0	
" 20		22 36.3	23 5.8
" 27	22 50.3	23 21.3	23 49.3
Sept. 3	23 28.3	23 57.3	
" 8	22 41.3	23 13.3	23 44.3
1885, Apr. 28		13 54.0	14 27.0
May 7	15 55.0	16 26.0	
" 10	13 30.0	13 59.0	14 27.5
" 12	15 9.0	15 40.0	
" 22			14 21.5
" 31	15 44.0	16 15.0	
June 10	14 19.0	14 51.0	

White Spots on Jupiter. These have been very numerous of late years, and some of them very persistent and remarkable. Beginning July 6, 1878, the note books of this Observatory abound with descriptions of the positions, appearance and motion of white spots. Very few observations, however, were made on them relative to a determination of the axial rotation of the planet. One of these white spots has been followed by Mr. Denning, of Bristol, England, since September, 1880. It has perpetuated its identity, under some fluctuations of brightness, and is still a notable marking on the Jovian surface. What is most remarkable is its rapid motion relatively to the red spot, since it makes the entire circuit of the great planet, and passes the red spot every 44½ days, as determined by Mr. Denning.

From this spot Prof. Hough and Mr. Denning derive the following values for the rotation period of the planet (*Observatory, 95*).

Hough.		Denning.	
1882–83	$9^h\ 50^m\ 9^s.8$	1882–83	$9^h\ 50^m\ 9^s.6$
1883–84	$9^h\ 50^m\ 12^s.7$	1883–84	$9^h\ 50^m\ 12^s.1$

Differing from the rotation period, as determined by the red spot, nearly 5½ min.

The rapidity of the changes in the white spots and nuclei on the northern edge of the southern belt has sometimes led me to question whether the appearance which we see is always really a motion of translation. I will select one instance out of many. The phenomenon was observed with great care, 1881, December 23. The night was exceedingly fine, and the surface of the great planet was rarely ever seen under better conditions of altitude and atmosphere. Every line and marking came out with a distinctness which was a wonder even to an observer of experience. The "Great Red Spot" was approaching the central meridian of the disc, and I had begun my usual observation of the transit of the preceding end, when my attention was directed to a condensed white nucleus, situated in the north margin of the great southern belt. The threads of the filar micrometer had been adjusted to the rotation axis of the planet, and one fixed thread was placed on one extremity of major axis of spot, and the movable thread upon the other end, and these threads were kept in this position by the driving clock and an adjusting screw.

At $7^h\ 7^m$ of local mean time the following end of red spot and the bright nucleus were on the same thread, or the bright spot was on the same Jovian meridian directly north of the following end of red spot. As it requires more than one hour for the Jovian rotation to carry the major axis of spot across the central meridian, and the changes in the relative position of the two objects must take place between my micrometer threads, I had a very rare opportunity to compare even slight changes. Not twenty minutes had passed till I could see independently of the threads that the white spot had a rapid motion relatively to the red spot. It was so marked, and proceeded so uniformly, that I resolved to measure it minutely. My observation of the transit closed at $8^h\ 10^m$, and then I estimated by the eye that the bright nucleus had gained on the following end of red spot, in one hour, three-eighths of the interval between my threads. The mean of a number of careful measures proved it to be three hundred and sixty-one thousandths of the interval, or $4''.33$. The question now occurs: Was this a motion of translation? If so, we shall have to believe that a motion can take place in the Jovian atmosphere at the rate of eight or ten thousand miles an hour. As this seems incredible, I prefer to think that this angular displacement is the index of a progressive transmission of light through lower and variable strata of atmosphere; or else a part of an auroral display. Neither of these hypotheses seems to me absurd. As the size and consistency of the nucleus seemed to change slightly during the observation, it is conceivable that the effect was due to a progressive transmission of light through changing mediæ. Also, after witnessing the grand auroral display of 1882, April 16, visible over a large part of North America, I can readily conceive that we might recognize such a phenomenon on a grander scale, on Jupiter.

Phenomena of Jupiter's Satellites. During the years 1878–79–80–81, the satellites were observed frequently, and the times of eclipses, occultations and transits of satellites and their shadows, were carefully noted. More recently, however, the claims on my time have prevented this, and they have been observed only casually. Perhaps this is the less to be regretted, as great improvements in the precision of observations of eclipses of Jupiter's satellites seem to be promised by the method adopted by Prof. Pickering, at Cambridge. Essentially, it consists in determining by a photometer their light-curves during the progress of an eclipse. A method somewhat different is proposed by M. Cornu, of Paris (*Comptes Rendus*, Vol. XCVI., Nos. 23–24). As none of my observations of these satellites have yet been published they are here given.

Date.	I. (Io)	II. (Europa)	III. (Gany'de)	IV. (Callisto)	Phase.	G. M. T.			Notes.
1878.						h.	m.	s.	
Aug. 15	Tr. ing.				Int. contact.	15	46	43	
15				Oc. reap.	Ex. contact.	16	13	45	
15	Sh. ing.				Int. contact.	16	20	12	
15				Ec. dis.	Light very faint.	16	42	44	
15				Ec. dis.	Totally exting.	16	44	18	
16	Ec. reap.				First seen.	15	54	56	Thin clouds.
16	Ec. reap.				Full brightness.	15	55	21	
19		Ec. reap.			First seen.	14	27	22	
19		Ec. reap.			Full brightness.	14	28	58	
23	Oc. dis.				Half hid.	14	49	10	
23	Oc. dis.				Total dis.	14	51	53	
23			Sh. ing.		Half on.	15	12	22	
23			Sh. ing.		Fully on.	15	14	20	
23			Tr. eg.		Int. contact.	15	49	46	
23			Tr. eg.		Ext. contact.	15	56	40	
26		Ec. reap.			First seen.	16	3	1	
26		Ec. reap.			Half brightness.	16	3	41	
26		Ec. reap.			Full brightness.	16	4	31	
30			Tr. ing.		Ext. contact.	15	42	10	
30			Tr. ing.		Half on.	15	48	41	
30			Tr. ing.		Fully on.	15	51	56	

Date.	I. (Io)	II. (Europa)	III. (Gany'de)	IV. (Callisto)	Phase.	G. M. T.			Notes.
1878.						h.	m.	s.	
Aug. 30	Oc. dis.				Ext. contact.	16	32	1	
30	Oc. dis.				Half hid.	16	36	4	
30	Oc. dis.				Total dis.	16	38	30	
31	Tr. eg.				Int. contact.	15	59	8	
31	Tr. eg.				Half off.	16	1	43	
31	Tr. eg.				Ext. contact.	16	5	42	
31	Sh. eg.				Int. contact.	16	51	4	
31	Sh. eg.				Half off.	16	52	15	
31	Sh. eg.				Total dis.	16	54	5	
Sept. 1				Ec. reap.	First appear.	15	11	20	
1				Ec. reap.	Full brightness.	15	16	40	
2		Oc. dis.			Ext. contact.	14	55	57	
2		Oc. dis.			Half hid.	14	58	58	
2		Oc. dis.			Total dis.	15	0	13	
4		Sh. eg.			Int. contact.	14	44	24	
4		Sh. eg.			Vanished.	14	50	28	Seeing not good.
10			Ec. dis.		Extinguished.	13	18	18	
10			Ec. reap.		First seen.	16	44	3	
10			Ec. reap.		Half brightness.	16	45	42	
10			Ec. reap.		Full brightness.	16	47	18	
11		Sh. ing.			First appear.	14	29	22	
11		Sh. ing.			Half on.	14	33	58	
11		Sh. ing.			Int. contact.	14	35	23	
11		Tr. eg.			Int. contact.	15	17	41	
11		Tr. eg.			Half off.	15	19	16	
11		Tr. eg.			Ext. contact.	15	24	00	
16	Tr. eg.				Half off.	14	5	58	
16	Tr. eg.				Ext. contact.	14	7	51	
18		Tr. ing.			Ext. contact.	14	48	51	
18		Tr. ing.			Int. contact.	14	54	23	
20		Ec. reap.			First seen.	14	10	30	
20		Ec. reap.			Full brightness.	14	16	17	
22	Oc. dis.				Ext. contact.	16	27	8	
22	Oc. dis.				Half hid.	16	28	48	
22	Oc. dis.				Total dis.	16	33	7	
26				Sh. ing.	Half on.	15	9	56	
26				Sh. ing.	Fully on.	15	12	20	
Oct. 5			Tr. eg.		Half off.	13	38	22	At 15h 28m. the shadow of III. was projected as an ellipse.
5			Tr. eg.		Ext. contact.	13	41	48	
9	Tr. eg.				Int. contact.	14	6	7	
9	Tr. eg.				Half off.	14	9	6	
9	Tr. eg.				Fully off.	14	13	52	
12			Tr. ing.		Ext. contact.	13	57	9	
12			Tr. ing.		Half on.	13	59	55	
12			Tr. ing.		Int. contact.	14	3	46	
22		Ec. reap.			First seen.	13	58	47	Planet put out of field.
22		Ec. reap.			Half brightness.	13	59	44	
22		Ec. reap.			Full brightness.	14	0	35	
Nov. 1	Tr. eg.				Int. contact.	14	23	47	
1	Tr. eg.				Half off.	14	26	52	
1	Tr. eg.				Ext. contact.	14	29	51	
2	Ec. reap.				First seen.	13	3	31	
2	Ec. reap.				Half brightness.	13	4	5	
2	Ec. reap.				Full brightness.	13	5	0	
9	Oc. dis.				Ext. contact.	11	23	24	
9	Oc. dis.				Total dis.	11	27	49	
18	Ec. reap.				First seen.	11	23	8	

Date.	I. (Io)	II. (Europa)	III. (Gany'de)	IV. (Callisto)	Phase.	G. M. T.			Notes.
						h.	m.	s.	
1878.									
Nov. 18	Ec. reap.				Full brightness.	11	24	56	
1879.									
July 1			Oc. dis.		Ext. contact.	18	11	0	
2	Ec. dis.				Total dis.	22	5	18	
11	Sh. ing.				Half on.	17	51	7	
11	Sh. ing.				Fully on.	17	52	37	Both I. and II. with their shadows on the disc at 18h 21m.
11		Tr. ing.			Ext. contact.	17	39	7	
11		Tr. ing.			Half on.	17	41	7	
11		Tr. ing.			Fully on.	17	43	37	
18		Sh. ing.			Half on.	19	19	24	
18		Sh. ing.			Fully on.	19	20	48	
18	Sh. ing.				Half on.	19	44	42	It was a beautiful sight to see two dark shadows and two bright discs on the surface of planet at once. The effect was heightened by the variegation of the surface.
18	Sh. ing.				Fully on.	19	45	30	
18		Tr. ing.			Ext. contact.	19	53	39	
18		Tr. ing.			Half on.	19	58	19	
18		Tr. ing.			Fully on.	19	59	48	
18	Tr. ing.				Ext. contact.	19	59	54	
18	Tr. ing.				Half on.	20	1	18	
18	Tr. ing.				Fully on.	20	3	0	
19				Oc. reap.	Projecting point.	15	17	50	
19					Ext. contact.	15	26	2	
19	Ec. dis.				Half brightness.	16	57	40	
19	Ec. dis.				Total dis.	16	58	30	
20	Tr. eg.				Int. contact.	16	40	51	
20	Tr. eg.				Half off.	16	42	16	
20	Tr. eg.				Ext. contact.	16	44	59	
27	Tr. ing.				Ext. contact.	16	7	25	
27	Sh. ing.				Int. contact.	16	7	53	Satellite and shadow in apparent ext. cont., as Jupiter is approach. op.
27	Tr. ing.				Half on.	16	9	38	
27	Tr. ing.				Int. contact.	16	12	0	
27		Ec. dis.			Half brightness.	16	32	54	
27		Ec. dis.			Total exting.	16	34	54	
27			Ec. dis.		Half brightness.	17	44	11	
27			Ec. dis.		Total exting.	17	46	33	
27	Sh. eg.				Int. contact.	18	20	40	At 18h 14m the disc of I. begins to encroach on its shadow.
27	Sh. eg.				Half off.	18	22	8	
27	Tr. eg.				Int. contact.	18	23	35	
27	Sh. eg.				Disappears.	18	24	45	
27	Tr. eg.				Half off.	18	26	13	
27	Tr. eg.				Ext. contact.	18	28	12	
28	Oc. reap.				Projecting point.	15	40	4	
28	Oc. reap.				Ext. contact.	15	41	21	
Sept. 3		Oc. dis.			Ext. contact.	18	54	32	
3		Oc. dis.			Half. hid.	18	56	35	
3		Oc. dis.			Total hid.	18	57	41	
4	Oc. dis.				Ext. contact.	15	5	44	
4	Oc. dis.				Half brightness.	15	7	13	
4	Oc. dis.				Total hid.	15	9	47	Very near planet. Had probably been visible 15 or 20 seconds. Used the slide, putting planet out of field.
4	Ec. reap.				First seen.	17	31	38	
4	Ec. reap.				Half brightness.	17	31	44	
4	Ec. reap.					17	33	12	
10	Tr. ing.				Ext. contact.	19	34	45	
10	Tr. ing.				Int. contact.	19	39	35	
12		Tr. ing.			Ext. contact.	15	51	42	
12		Tr. ing.			Half on.	15	53	57	
12		Tr. ing.			Int. contact.	15	55	22	
12	Tr. eg.				Half off.	16	19	42	

Date.	I. (Io)	II. (Europa)	III. (Gany'de)	IV. (Callisto)	Phase.	G. M. T.			Notes.
1870.						h.	m.	s.	
Sept. 12	Tr. eg.				Ext. contact.	16	21	24	
12	Sh. eg.				Int. contact.	16	36	42	
12	Sh. eg.				Disappearance.	16	39	42	
13				Tr. eg.	Half off.	14	19	14	
13				Tr. eg.	Ext. contact.	14	23	6	
20	Ec. reap.				First seen.	15	50	33	
20	Ec. reap.				Full brightness.	15	52	3	
21				Oc. dis.	Ext. contact.	15	36	28	
21				Oc. dis.	Half hid.	15	38	58	
21				Oc. dis.	Total hid.	15	43	59	
21		Ec. reap.			First seen.	16	22	58	
21		Ec. reap.			Half brightness.	16	23	53	
21		Ec. reap.			Full brightness.	16	24	58	
Oct. 4	Oc. dis.				Ext. contact.	16	33	14	
4	Oc. dis.				Half hid.	16	34	58	
4	Oc. dis.				Total dis.	16	37	11	
5	Sh. ing.				Half on.	14	36	54	
5	Sh. ing.				Int. contact.	14	37	36	
5	Tr. eg.				Int. contact.	15	59	24	
5	Tr. eg.				Half off.	16	1	24	
5	Tr. eg.				Ext. contact.	16	4	12	
7		Sh. eg.			Int. contact.	16	33	25	
7		Sh. eg.			Disappearance.	16	36	40	
8				Ec. dis.	Total dis.	15	12	45	Slight haze.
9			Oc. dis.		Ext. contact.	14	1	55	
9			Oc. dis.		Half hid.	14	5	25	
9			Oc. dis.		Total hid.	14	9	44	
12	Tr. ing.				Ext. contact.	15	32	28	
12	Tr. ing.				Half on.	15	34	8	
12	Tr. ing.				Fully on.	15	35	18	
12	Sh. ing.				Fully on.	16	32	36	
14		Tr. ing.			Ext. contact.	14	20	18	
14		Tr. ing.			Half on.	14	22	48	
14		Tr. ing.			Fully on.	14	24	18	
14		Sh. ing.			Half on.	16	24	49	
14		Sh. ing.			Fully on.	16	26	12	
19	Tr. ing.				Ext. contact.	17	20	20	The shadow of III. at first elongated, but soon became round; the phenomenon resembled the black drop. Shadow remained for half an hour nearly in contact with following end of spot. At ingress shadow gained on spot, was stationary near cen., then retrograd'd relatively to end of spot.
19	Tr. ing.				Half on.	17	21	45	
19	Tr. ing.				Fully on.	17	23	5	
20			Sh. ing.		Fully on.	12	3	18	
20			Sh. eg.		Int. contact.	15	22	12	
20			Sh. eg.		Half off.	15	24	00	
20			Sh. eg.		Disappears.	15	27	48	
21	Tr. ing.				Ext. contact.	11	48	24	
21	Tr. ing.				Half on.	11	50	36	
21	Tr. ing.				Fully on.	11	51	42	
21	Tr. eg.				Half off.	14	6	00	
21					Ext. contact.	14	7	42	
23		Ec. reap.			First seen.	16	4	12	
23		Ec. reap.			Half brightness.	16	4	40	
23		Ec. reap.			Full brightness.	16	6	00	
27			Tr. eg.		Int. contact.	14	42	54	
27			Tr. eg.		Half off.	14	44	42	
27			Tr. eg.		Ext. contact.	14	48	42	
28	Tr. ing.				Ext. contact.	13	36	54	
28	Tr. ing.				Half on.	13	37	48	
28	Tr. ing.				Int. contact.	13	39	24	

Date.	I. (Io)	II. (Europa)	III. (Gany'de)	IV. (Callisto)	Phase.	G. M. T.			Notes.
						h.	m.	s.	
1879.									
Oct. 28	Sh. ing.				Half on.	14	51	48	
28	Sh. ing.				Int. contact.	14	52	42	
29	Ec. reap.				First seen.	14	26	6	
29	Ec. reap.				Half brightness.	14	26	26	
29	Ec. reap.				Full brightness.	14	27	7	
30	Sh. eg.				Fully off.	11	35	18	
Nov. 5	Oc. dis.				Ext. contact.	12	46	1	
5	Oc. dis.				Half hid.	12	47	50	
5	Oc. dis.				Tot. hid.	12	50	53	
5	Ec. reap.				First seen.	16	22	13	
5	Ec. reap.				Half brightness.	16	22	43	
5	Ec. reap.				Full brightness.	16	23	28	
6	Tr. eg.				Int. contact.	12	13	10	
6	Tr. eg.				Half off.	12	15	8	
6	Tr. eg.				Ext. contact.	12	16	12	
6	Sh. eg.				Int. contact.	13	27	40	
6	Sh. eg.				Fully off.	13	30	40	
6		Oc. dis.			Ext. contact.	15	54	55	
6		Oc. dis.			Half hid.	15	57	40	
6		Oc. dis.			Tot. hid.	15	59	55	
7			Ec. reap.		First seen.	13	20	38	
7			Ec. reap.		Half brightness.	13	21	33	
7			Ec. reap.		Full brightness.	13	22	26	
12	Oc. dis.				Ext. contact.	14	42	18	
12	Oc. dis.				Half hid.	14	42	58	
12	Oc. dis.				Tot. hid.	14	44	24	
14			Oc. reap.		Ext. contact.	12	13	18	Uncertain on account of clouds.
14	Ec. reap.				Half brightness.	12	47	47	First appearance not not'd on account of clouds.
14	Ec. reap.				Full brightness.	12	48	25	
21			Oc. dis.		Ext. contact.	12	32	8	
21			Oc. dis.		Half hid.	12	34	44	
21			Oc. dis.		Tot. hid.	12	39	18	
21	Ec. reap.				First seen.	14	42	23	Very light clouds.
21	Ec. reap.				Full brightness.	14	43	32	
29	Tr. eg.				Half off.	12	26	3	
29	Tr. eg.				Ext. contact.	12	27	48	
Dec. 6				Sh. eg.	Int. contact.	12	39	38	
6				Sh. eg.	Total disap.	12	43	18	
1880.									
Jan. 8				Transit.	Central merid.	13	10	48	Satellite very dark.
14			Sh.			12	53	18	Sh. of III. almost center of red spot. Sh. black, as on zones of planet.
14			Sh.			13	22	18	Shadow near edge of spot, (s.p.).
Feb. 5		Sh.				11	36	00	Shadow just off prec. end of red spot.
July 10		Sh.				21	6	00	Shadow near prec. end of red spot.
19		Oc. reap.			Projecting point.	22	26	33	
19		Oc. reap.			Half off.	22	27	38	
19		Oc. reap.			Ext. contact.	22	29	56	
Sept. 3			Oc. reap.		Half off.	16	47	13	
3			Oc. reap.		Ext. contact.	16	49	3	
5		Sh. ing.			Half on.	16	16	0	
5		Sh. ing.			Fully on.	16	17	42	The shadow of I. passed along the narrow strip of light, north of red spot, nearly filling it.
5	Tr. ing.				Ext. contact.	22	21	18	
5	Tr. ing.				Half on.	22	23	8	
5	Tr. ing.				Fully on.	22	24	18	
15	Ec. dis.				Tot. ext.	15	10	48	
23	Tr. ing.				Ext. contact.	14	40	35	
23	Tr. ing.				Half on.	14	42	33	

Date.	I. (Io)	II. (Europa)	III. (Gany'de)	IV. (Callisto)	Phase.	G. M. T.			Notes.
1880.						h.	m.	s.	
Sept. 23	Tr. ing.				Fully on.	14	44	18	
23	Tr. eg.				Int. contact.	16	50	33	
23	Tr. eg.				Half off.	16	51	48	
23	Tr. eg.				Ext. contact.	16	53	18	
28			Tr. ing.		Ext. contact.	14	35	57	
28			Tr. ing.		Half on.	14	40	12	
28			Tr. ing.		Fully on.	14	42	42	
Oct. 1	Oc. reap.				Projecting point.	15	46	20	
1	Oc. reap.				Half off.	15	46	55	
1	Oc. reap.				Fully off.	15	47	55	
5			Sh. ing.		Half on.	17	34	54	Shadow in apparent contact with satellite.
5			Sh. ing.		Fully on.	17	38	36	
5			Tr. ing.		Ext. contact.	17	47	54	
5			Tr. ing.		Half on.	17	54	54	
5			Tr. ing.		Fully on.	18	4	24	
8	Oc. dis.				Ext. contact.	15	17	54	
8	Oc. dis.				Half on.	15	19	54	
8	Oc. dis.				Tot. hid.	15	21	54	
9	Tr. eg.				Ext. contact.	14	43	36	
9	Tr. eg.				Half on.	14	46	24	
9	Tr. eg.				Ext. contact.	14	48	24	
9	Sh. eg.				Half off.	14	49	54	
9	Sh. eg.				Disappears.	14	52	24	
23			Oc. dis.		Ext. contact.	13	40	48	
23			Oc. dis.		Half hid.	13	44	42	
23			Oc. dis.		Tot. hid.	13	51	42	
23		Oc. dis.			Ext. contact.	15	5	30	
23		Oc. dis.			Half hid.	15	8	6	
23		Oc. dis.			Tot. hid.	15	10	42	
23	Tr. ing.				Ext. contact.	16	1	24	
23	Tr. ing.				Half on.	16	4	12	
23	Tr. ing.				Fully on.	16	5	24	
24	Ec. reap.				First seen.	15	52	23	
31	Oc. dis.				Ext. contact.	14	58	56	
31	Oc. dis.				Fully hid.	15	1	26	
Dec. 1	Sh. ing.				Half on.	15	1	30	
1	Sh. ing.				Int. contact.	15	2	24	
2	Ec. reap.				First seen.	14	29	7	
2					Full brightness.	14	29	50	
1881.									
Jan. 1	Oc. dis.				Half on .	14	10	24	
1	Oc. dis.				Tot. hid.	14	11	46	
Aug. 2	Tr. ing.				Half on.	22	35	43	
2	Tr. ing.				Fully on.	22	37	38	
1882.									
Feb. 28	Oc. dis.				Ext. contact.	13	32	8	
28	Oc. dis.				Half hid.	13	35	48	
28	Oc. dis.				Fully hid.	13	37	43	

Occultation by Jupiter of the Fixed Star, 4 Geminorum, Magnitude 7. The place of this star is well determined, and is given in the following catalogues:

Bessel's Bradley	No. 895	*Piazzi*	V^h— 344
Lalande	. 11679	*Armagh*	1387

Greenwich 7 Year Catalogue, 788.

1882, November 7. The images of both Jupiter and star were very steady and sharp. As Jupiter was retrograding, the occultation (immersion) occurred on the western side of the planet, and at the north border of the south equatorial belt, or rather between the north border and middle. The approach of the margin of the disc to the star was watched for more than one hour. At 11^h 28^m 10^s.65, L.M.T., the star seemed for a moment to disappear, but was plainly seen a moment later. It was then within the comparatively dark outline of the disc, and there seemed a well defined notch in the otherwise continuous and even margin of the disc. This notch continued 46^s.26, when it vanished, and the light of the star was entirely extinguished at 11^h 28^m 56^s.91, of local mean time. Power used 200.

THE PLANET SATURN.

During the years 1876–77–78–79–80, extended series of observations were made at the MORRISON OBSERVATORY, of the conjunctions of the satellites of Saturn with the ends of the ring, and with the edge of the ball. These observations were instituted at the instance of Mr. Albert Marth, of England, who for a number of years has published very full and valuable ephemerides for facilitating observations of satellites, and of physical phenomena on the planets *Mars, Jupiter, Saturn, Uranus* and *Neptune.* As these observations were published from year to year in the *Astronomische Nachrichten*, they are not repeated in this publication (*vide A. N.* 2131–2189–2264–2314). In 1880–81 press of other work curtailed the observations of these conjunctions, and they were only observed at intervals. These somewhat casual observations not having been hitherto published, are here inserted. The abbreviations nf, np, sf and sp, refer to the quadrants in which the observation was made, viz: north following, north preceding, south following, and south preceding.

Date.	Satellite.	Quadrant.	In conjunct'n with.	G. M. T.	Remarks.
				h. m.	
1880, Sept. 4	Tethys	sf	Ring	17 56	
“ 5	Tethys	np	Ring	16 35	
“ 5	Teth. & Mim. (?)	sp	Each other	17 48	Tethys north of Mimas (?) 7″ or 8″.
“ 5	Teth. & Mim. (?)	sp	Each other	18 6	Tethys *now* west of Mimas (?), which was moving in towards end of ring sp. *Enceladus* obs., nf at 17h 46m.
“ 9	Dione	sf	Ring	15 51.9	
“ 10	Dione	nf	Ring	17 2.1	Past end of ring, 8m or 10m.
“ 10	Rhea	np	Ring	22 46	
“ 16	Tethys	np	Ring	17 26	
“ 23	Tethys	sf	Ring	14 52	
1880, Oct. 3	Tethys	nf	Ring	16 17	
“ 9	Tethys	nf	Ring	15 44	
“ 9	Tethys & Rhea.	nf	Each other	15 50.5	

Date.	Satellite.	Quadrant.	In conjunct'n with.	G. M. T.	Remarks.
				h. m.	
1880, Oct. 11	Tethys	nf	Ball	14 49.9	
" 23	Rhea	sf	Ring	14 35.9	
" 23	Enceladus	nf	Ring	16 22.0	Just past.
" 31	Dione	sf	Ring	15 15.4	
1880, Nov. 1	Rhea	sf	Ring	15 27.0	Barely past.
" 1	Dione & Rhea	nf and sf	Each other	15 46.0	In same perpendicular to ring.
" 1	Dione	nf	Ring	16 2.4	
" 6	Enceladus	np	Ring	15 30.0	
" 6	Tethys	nf	Ring	15 39.0	
" 11	Tethys	sf	Ball	14 18.6	
" 13	Tethys	sf	Ring	13 32.4	
" 13	Mimas (?)	sp	Ring	14 8.0	*Enceladus* was plainly in view also,
" 26	Dione	np	Ring	15 2.0	
1880, Dec. 11	Dione	sf	Ring	16 12.0	
" 14	Tethys	np	Ring	17 8.5	
" 14	Enceladus	nf	Ring	17 18.0	
1881, Jan. 1	Tethys	sf	Ball	13 22.3	
" 1	Mimas (?)	west		13 26.0	Near west elong., about 6″ from end of ring.
" 1	Mimas (?)	west		14 3.0	Lost near contact with ring.
" 1	Tethys	sf	Ring	15 41.0	

Miscellaneous Observations of Satellites, Position, Angle, and Distance from center of Saturn. 1878, Sept. 22, *Titan* near inferior conjunction, north of planet, and distant (by estimation) from edge of ball 1″.5. Mean of eight double measures of *Titan's* distance from east end of ring 19″.58 at 15^h $24^m.5$, G.M.T.

Titan midway between the tangent threads, and in apparent contact with the ball, at 16^h $14^m.7$, G.M.T. (inf. conj.). Mean of thirteen comparisons.

Titan, north of planet, and distant from the edge of ball 1″.7. Measures from the west end of ring 19″.24, at 17^h $27^m.4$, G.M.T. Mean of four double measures.

MISCELLANEOUS OBSERVATIONS OF SATELLITES.—POSITION-ANGLE AND DISTANCE.

Date.	Satellite.	Direction.	p	G. M. T.	s	G. M. T.	Remarks.
			°	h. m.	″	h. m.	
1878, Sept. 28	Enceladus	Westward	269.83	16 8.4	38.48	15 46.0	Near western elongation.
1878, Oct. 2	Tethys	Westward	273.75	15 58.0	46.56	15 45.4	
" 5	Enceladus	Westward	273.70	14 56.2	35.65	14 59.0	
" 9	Enceladus	Westward	266.34	14 58.9	38.17	14 52.2	
" 11	Japetus	Northw'd			86.53	14 12.0	Very near inferior conjunction.
" 11	Dione	Westward	272.50	16 20.9	60.17	16 38.7	
" 11	Enceladus	Eastward	87.00	16 58.9	36.91	16 58.9	
" 18	Tethys	Eastward	96.50	14 43.2	41.52	14 42.0	
" 19	Dione	Westward	275.75	16 23.9	51.70	16 15.3	
" 19	Tethys	Westward	274.83	16 54.0	47.24	16 41.4	
" 22	Dione	Westward	273.71	15 17.3	53.95	15 37.3	
" 29	Enceladus	Eastward	94.17	14 13.5	33.67	14 16.1	
" 29	Dione	Eastward	94.17		54.96	14 26.0	In direction of *Enceladus*.
" 31	Titan	Westward	265.78	13 12.5	44.90	13 9.6	*Titan* approaching the ball.

Date.	Satellite.	Direction.	*p*	G. M. T.	*s*	G. M. T.	Remarks.
			°	*h.* *m.*	"	*h.* *m.*	
1878, Oct. 31	Enceladus	Westward	273.27	13 22.9	38.11	13 30.0	
" 31	Rhea	Eastward	99.77	13 46.0	33.25	13 47.0	
1878, Nov. 1	Titan	Eastward	105.06	12 38.2	29.11	12 41.3	*Titan* recently occulted.
" 1	Rhea	Eastward	93.58	15 16.0	79.49	15 17.8	
" 1	Ti. and Di.	N. & S.			7.37	14 56.9	*Titan* south of *Dione*.
" 4	Rhea	Westward	266.97	13 29.6	27.73	13 30.9	
" 4	Tethys	Eastward	96.97	14 21.4	41.24	14 19.6	
" 7	Dione	Westward	276.39	15 42.4	35.89	15 39.7	
" 7	Tethys	Westward	275.14	16 11.0	43.83	16 4.8	
" 8	Titan	Eastward	89.96	15 36.0	55.91	15 39.5	
" 9	Titan	Westward	305.92			12 13.3	Seen as a projecting point. Point of egress from transit.
" 9	Titan	Westward				12 24.0	Fully off the ball.
" 11	Tethys	Westward	272.12	15 22.5	25.80	15 25.9	
" 17	Titan	Eastward	101.50	15 39.8	42.80	15 41.7	
" 17	Dione	Eastward	94.87	16 5.1	57.21	16 6.1	
" 18	Titan	Eastward	96.32	14 12.8	106.18	14 15.54	
" 18	Rhea	Eastward	98.78	14 40.6	27.69	14 36.6	
" 18	Dione	Westward	274.59	15 1.4	38.74	15 3.2	
" 18	Japetus	Southw'd	216.92	15 15.9	99.90	15 16.0	Approaching superior conjunction.
" 22	Rhea	Westward	269.47	13 26.5	34.03	13 30.1	
" 22	Tethys	Westward	274.58	14 12.9	42.56	14 16.6	
" 22	Enceladus	Westward	272.92	14 27.0	32.11	14 32.9	
" 22	Dione	Eastward	97.92	14 49.0	26.69	14 51.8	
" 27	Tethys	Eastward	95.67	12 54.6	39.52	12 57.8	
" 27	Dione	Westward	274.17	13 36.0	39.74	13 24.6	
" 27	Titan	Westward	273.78	13 49.5	141.92	13 51.1	
" 28	Dione	Eastward	95.28	14 37.0	55.96	14 42.82	
" 28	Rhea	Eastward	95.30	14 52.1	78.00	14 57.68	
" 28	Tethys	Westward	271.42	15 9.2	26.66	15 10.00	
1878, Dec. 4	Dione	Eastward	92.27	11 10.5	28.24	11 23.10	
" 4	Rhea	Westward	275.91	12 25.0	36.16	12 29.1	
" 4	Titan	Eastward	96.89	12 54.2	102.59	12 52.3	

MISCELLANEOUS OBSERVATIONS OF SATELLITES.

(TRANSIT DIFFERENCES ON CHRONOGRAPH, BETWEEN THE CENTER OF SATURN AND SATELLITES. THE TRANSIT OF THE CENTER IS THE MEAN OF TRANSIT OF THE LIMBS OF THE BALL. THE MICROMETER WAS CAREFULLY ADJUSTED TO THE DIURNAL MOTION.)

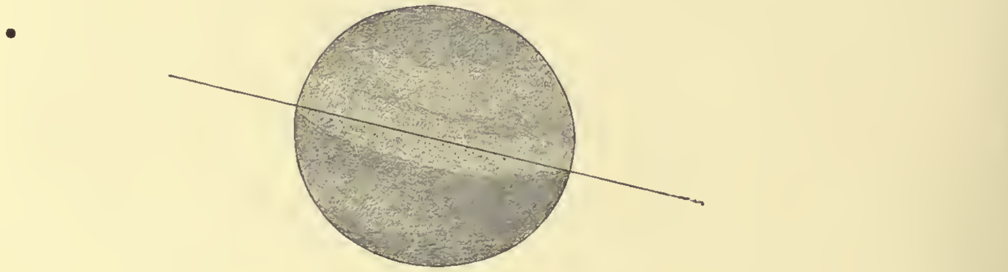
Date.	Satellite.	Direct'n from Center.	Distance.		G. M. T.	Comps.
			$\Delta\alpha$	$\Delta\delta$		
			s.	"	*h.* *m.*	
1878, Nov. 7	Titan	Following	7.94		16 45.3	9
" 7	Rhea	Preceding	4.18		16 50.2	6
" 7	Dione	Preceding	2.78		16 52.9	8
" 8	Titan	Following	3.84		15 3.7	5
" 8	Rhea	Preceding	4.48		15 6.6	5
" 11	Titan	Preceding	9.73		15 48.1	5
" 11	Tethys	Preceding	1.55		15 51.0	5
" 11	Dione	Following	1.62		15 52.2	5
" 13	Titan	So. preceding	11.94	11.00	13 58.8	5
" 13	Rhea	Precedes	1.76	0.00	14 5.3	5
" 13	Dione	Precedes, s.	3.76	4.36	14 11.3	5
" 13	Enceladus	Following, n.	2.33	1.97	14 31.7	6
" 21	Titan	Following, s.	12.66	13.77	15 23.6	4
" 21	Rhea	No. preceding	5.27	5.13	15 28.8	4

Date.	Satellite.	Direct'n from Center.	Distance.		G. M. T.	Comps.	
			$\Delta\alpha$	$\Delta\delta$			
			s.	″	h. m.		
1878, Nov. 21	Tethys	So. following	3.03	4.53	15 38.5	5	
" 21	Dione	No. preceding	3.67	7.46	15 33.9	5	
" 23	Titan	So. following	7.74	4.96	15 4.9	4	
" 27	Titan	No. preceding	9.59	10.32	14 46.0	4	
" 27	Dione	Preceding	2.21	0.00	14 51.0	4	
" 27	Tethys	So. following	2.12	2.28	14 54.1	6	
" 27	Rhea	So. following	1.69	4.30	15 24.5	5	
1879, Jan. 25	Titan	So. following	9.80	3.23	13 44.7	6	
" 23	Rhea (?)	So. following	2.75	5.02	13 54.8	8	
1879, Feb. 1	Titan	So. preceding	10.43	6.01	15 47.2	6	
" 1	Dione (?)	No. preceding	3.62	5.90	13 58.4	5	
" 3	Titan	So. preceding	5.77	1.27	13 6.3	6	

Dimensions of Saturn and of his Outer Ring. In 1878–79 a few measures of the major axis of the outer ring, its position angle, and the equatorial diameter of the ball, were made, not at all to be set forth as authoritative, but simply to try how nearly careful filar micrometer measures, made under favorable conditions, would conform to those made with the heliometer, or with double image micrometers. As Bessel's measures have priority, and have for many years been considered the standard authority on the dimensions of the Saturnian system, and since these were reduced to the mean distance of Saturn from the sun, I have reduced mine to the same distance. Assuming the mean distance to be 9.53885, the actual and reduced measures stands thus—

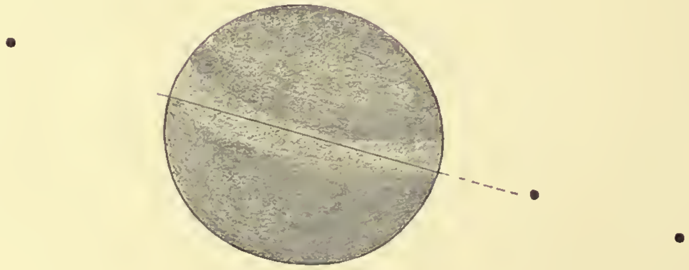
Date.	G. M. T.	Outer Ring, Act. Meas.	Outer Ring, Reduced.	Pos. Angle	No. Obs.	Weight	Eq. Diam., Act. Meas.	Eq. Diam., Reduced.	No. Obs.	Remarks.
	h.	″	″	°			″	″		
1878, Oct. 18	14.4	44.248	40.086	93.70	7	4				Scale of weights from 1 to 5.
" 19	15.3	43.617	39.551	94.02	7	4	20.237	18.350	4	
" 22	14.2	44.923	40.851	94.68	6	4	19.370	17.841	4	
1878, Dec. 4	15.3	41.540	40.240	95.89	8	5				
1879, Feb. 7	13.0	36.800	39.412		4	4	16.72	17.907	3	
Means			40.028					18.033		

Bessel's value for the major axis of the outer ring, at the sun's mean distance, is 39″.311; and for the equatorial diameter of the ball 17″.053. I have not the records at hand, but I learn that Struve's value is about 1″ greater than these, and that those of Encke and Galle are still a little greater. The measures given in the table are probably intermediate between the heliometer measures of Bessel and the later measures of Encke and Galle.



1878, February 4. 6h. 30m., Loc. M.T.

I.



1878, February 5. 6h. 25m., Loc. M.T.

III.

(Observing Book.)

SATURN.

Observations on the Rings at Disappearance in 1878. As is now well known, the rings of Saturn twice disappear during the 29.5 years in which he performs his journey round the sun. To the early astronomers, using the telescope, this disappearance was a source of great perplexity. Galileo was one of the first to notice the phenomenon. He had for several years observed Saturn, considering it triform, that is a globe, with two smaller ones attached; and when, in 1612, he saw only a single round globe, he was much chagrined, supposing that he had been imposed on by some optical illusion. Huyghens, watching the disappearance in 1665, and the reappearance in the autumn of the same year, was led to a proper conception of the phenomenon, which he announced to astronomers under a famous combination of letters. The letters of the combination (recording and yet hiding his discovery), when properly arranged, give this sentence —

"*Annulo cengitur, tenui, plano nusquam cohærente, ad eclipticam inclinato,*"

affording a description at once accurate and complete.

The disappearance, in February, 1878, was watched at the MORRISON OBSERVATORY with great care, and as definite observations of the appearance presented, were made from night to night, as the low altitude of the planet in the south-western sky allowed. The following notes and sketches are copied from the observing books.

1878, February 3, 7^h 30^m, L.M.T. Seeing very fine. Examined Saturn's ring very carefully for half an hour. The ring seems projected across the disc or ball, as a very fine, sharp line. The extensions on each side of the ball towards the ansæ form a very fine continuous white line. The two extensions about equally bright, except that immediately at the ansa on west (following) side; the light broadened, so much so, that (having no ephemeris of the satellites) I was in doubt whether the appearance was not due to a satellite (*Tethys* or *Enceladus*) in apparent contact with the end of the ring. The compression of the ball unusually manifest. Dusky bands very plain. Figure 1 shows the projection of the ring in the field of the telescope. The three satellites are in their relative position.

1878, February 4, 6^h 30^m, L.M.T. For about twenty minutes, a break in the clouds gave opportunity for a very satisfactory view of Saturn and his ring. Seeing moderately good for about ten minutes. Across the ball the ring is still seen very sharply projected. The ends towards the ansæ still very fine white lines. At some moments these parts of the ring seemed to form an irregular series of discontinuous bright short lines. Only two satellites recognized. The dusky bands of Saturn very distinct. The compression unusually obvious without measures. Along the whole southern edge of the disc I noticed a dark fringe, somewhat irregular in outline.

1878, February 5, 6^h 21^m, L.M.T. Observed Saturn and the remnant of his ring for half an hour. Seeing very poor, although entirely clear. The projection of the ring on the ball could be faintly seen, though not constantly. On the preceding side, the edge of the ring could only be seen near the disc of the planet. On the following side, the edge could be faintly recognized, the low altitude and poor seeing giving the impression of scintillations of light from discontinuous points. Three satellites in view, as in Figure 3. As the object glass faced a strong southwest wind, and the axis of the telescope was nearly horizontal, I could barely distinguish whether one of the satellites was not the ansa of the ring on the following side. I am quite sure, however, it was a satellite. The compression was still very marked. Seeing miserably poor.

1878, February 6, 7^h, L.M.T. Observed the ring of Saturn. Hazy in southwest, and since the planet was near the horizon the view was unsatisfactory. The projection of the ring on the ball very faintly and inconstantly seen. On the following side I could detect no trace of the ring, except near the ansa. Here, when the planet was out of the field, I could just catch an inconstant, faint gleam of light. On the preceding side, when the planet was out of the field (or rather occulted by a slide), a series of disconnected points was several times faintly recognized, the light seeming to broaden out near the ansa. The great planet seemed entirely despoiled of his glory and beauty. Only one satellite could be seen, *Titan* slowly receding from his eastern elongation.*

The apparent colors of Saturn and Mars, as seen at their near approach, 1879, June 29–30. [From a letter to the Astronomer Royal, Sir George B. Airy, *Monthly Notices*, Vol. XXXIX.].

"1879, June 29, $14^h.5$–15^h, L.M.T. Spent some time in looking at the planets *Saturn* and *Mars* in their very near approach. In the finder both appeared at once — *Mars* with his usual ruddy glow, and *Saturn* tinged with a greenish hue, which was more and more manifested to be in a great part subjective, or the effect of contrast. In the large telescope, with a micrometer eye-piece of 150, they could not both be seen at once. A separate examination showed *Saturn* with his ring very distinct, three satellites east and south, and one north and west. *Mars* was gibbous and well defined, with his fiery red glare on the illuminated side, and a tinge of green on the defective limb. Always after looking at *Mars* for some minutes, when the eye was newly turned on *Saturn*, a reddish tinge was observed, which gradually disappeared, showing (I think) that the overmastering power of the light of *Mars* caused such an impression on the optic nerve as to last long enough to produce a purely subjective effect.

---

* After February 6, no observations could be obtained, the planet being near horizon, and weather unfavorable.

Next, a low power eye-piece of 50 was screwed into the tube, and both planets were readily brought into the same field. The effect of colors then became more apparent. The illuminated surface of *Mars* was clearly defined and ruddy, while *Saturn* showed his usual dull white light; but whenever the eye passed rapidly from *Mars* to *Saturn*, the latter (especially near the center of the disc) always showed, for a few seconds, a decidedly reddish tint. It was a rare and grand sight to have both these planets in the same field with a fine objective of $12\frac{1}{4}$ inches, and I parted from the view with reluctance, as one I may never have again. The planets were afterward examined under an eye-piece of 275. As the morning was fine, they presented a splendid appearance. They were now so far out of the field as to produce no subjective effect, as before. No measures were attempted. Arrangements were made to examine the planets on the morning of June 30 (astronomical time), but clouds prevented.

FIGURE AND DIMENSIONS OF URANUS.

In 1877, I made a few measures of the diameters of Uranus, rather as a practice in measuring planetary discs with a filar micrometer, than with the expectation of a very consistent and accurate result. The measures were laid away and almost forgotten, until interest in this subject was stimulated by a favoring occurrence. In 1883, Prof. A. Safarik of Prague, called the attention of astronomers to the unusually favorable opportunity for investigating the figure of Uranus, arising from his position in his orbit, near the ascending node of the orbit plane of his satellites (*A. N.*, 2505). The plane of the orbits of the satellites being nearly perpendicular to the ecliptic, according to analogy, it is presumable that the planet's equator is in the same plane, and that on the earth, we may then see the profile of its ellipsoid, in its true position, relatively to the axis of rotation. In his paper (translated in *Observatory*, No. 74), Prof. Safarik cites the testimony of Sir William Herschel, that *Uranus* appeared round in 1782, and strikingly elliptical in 1792–94; of Mädler, whose measures with the Dorpat refractor in 1842–43 gave for the compression $\frac{1}{10}$ and $\frac{1}{11}$; of Vogel, who in 1871 saw the planet perfectly round, and of Prof. Newcomb, who in 1874–5 took no account of its ellipticity. He also gives a number of instances, in which he himself had examined the planet, extending from 1877 to 1883, and in every instance it appeared strikingly elliptical — more decidedly so than either *Jupiter* or *Saturn*.

So far as I know, the only astronomers who have furnished measures of *Uranus* in accordance with the suggestion of Prof. Safarik, are Prof. G. V. Schiaparelli of the Royal Observatory, Milan (*A. N.*, 2526), and (*A. N.*, 2608); Dr. M. Wilhelm Meyer, of the Observatory at Geneva (*A. N.*, 2524); Dr. E. Millosevich, of the Royal Observatory at Rome (*A. N.*, 2528), and Prof. C. A. Young, of the College of New Jersey, Princeton (*A. N.*, 2545). The work of Prof. Schiaparelli was done in Italian skies, with a very fine refractor of 8 inches aperture; that of Dr. Meyer, with a refractor of 10 inches aperture; that of Dr. Millosevich, with a refractor whose aperture is 9 inches, and that of Prof. Young, with the great refractor of the Halstead Observatory, whose objective is 23 inches in diameter. Besides the observations of the distinguished astronomers just mentioned, a very careful series of measures was made in 1884, by Prof. Seeliger, with the 10½-inch refractor and Repsold micrometer of the Munich Observatory. His observations involve a method hitherto little used in micrometer measures. In order to eliminate the effect of systematic errors depending on direction, he placed a reflecting rectangular prism between the eye-piece and the eye. This prism was capable of rotation round the optical axis of the telescope, so that the micrometer threads might appear to be placed in any desired direction. His measures were made in four different directions, and he reaches the conclusion that the disc of the planet is a perfect circle.

The measures of Prof. Schiaparelli include not only the diameters of the disc, but also the position angles of the major axis of the apparent ellipsoid, and of the apparent orbits of the satellites. His first series of measures, made in 1883, gave these angles 197°.3 and 195°.3, respectively; while the second series, in 1884, gave them 197°.3 and 195°.5. The correspondence of these angles in the two series is remarkable, and tends to show that the assumed coincidence of the orbit plane of the satellites with the equatorial plane of the planet is justified. The observations of the first series extend from April 12 to June 7, and afford twenty-five independent determinations of the compression. The observations of the second series extend from March 28 to June 4, and afford eighteen independent determinations. In the second series an effort was made to avoid systematic error, by keeping the line joining the eyes either parallel or perpendicular to the equatorial diameter. The effort was in part frustrated by unfavorable weather. Dr. Meyer measured the diameter in the direction of the parallel on nine evenings, between February 14 and April 12, taking twenty measures on each occasion; also, in a direction perpendicular to this, or in that of a circle of declination on six evenings, between March 11 and April 12. The measures of Dr. Millosevich, in 1883, were made on eight evenings, and with one exception, always in the direction of a declination circle, or of position angle zero. The observations extend from April 16 to May 11. The measures of Prof. Young extend from May 18 to June 19, and were made on eight nights, giving fourteen independent determinations of equatorial and polar diameters. For the sake of ready comparison the results of all these measures are given in the subjoined table. All the measures have been reduced to the distance 19.1826, of which the common logarithm is 1.28291.

RESULTS OF THE MEASURES.

Date.	Observer.	Equatorial Diameter.	Polar Diameter.	$\frac{a-b}{a}$ Compression.	Remarks.
1883	Schiaparelli	″ 3.911 ± 0.020	″ 3.555 ± 0.024	$\frac{1}{10.98 \pm 0.93}$	2a = 3″.904, 2b = 3″.577 means. Neglecting compression, 3″.741.
1884	Schiaparelli	3.898 ± 0.020	3.600 ± 0.024	$\frac{1}{13.09 \pm 1.35}$	
1883	Meyer	3.989 ± 0.025	4.015 ± 0.044	0.0	Mean 4″.002.
1883	Millosevich	3.638	3.645	0.0	Polar diam. only measured May 11-15. Meas. mean = 3″.642. Reale Academia dei Lincei, Serie 3, Vol. XIX
1886	Millosevich	3.638	3.648	0.0	
1883	Young	4.280 ± 0.022	3.974 ± 0.030	$\frac{1}{14}$	Neglecting compression, 4″.127.
1884	Seeliger	3.915 ± 0.045	3.915 ± 0.045	0.0	Akad. d. Wiss., 1884. Heft. 2.

Neglecting compression, the general mean of all these measures is 3″.885.

I regret very much that I was unable to make any measures in 1883–4. It is scarcely permissible to compare my own measures made in 1877, with those made by skillful observers, and under the most favorable conditions. It moreover tends to lessen the weight of these measures, that it was my first work on a planetary disc.

Thinking that my results may not be entirely useless, I have revised the work of eight years ago, and reduced the measures to the distance of the previous table, 19.1826. The earlier measures were made with the planet east of meridian, the larger number when it was very near the meridian, and the later ones when it was west of the meridian. When these measures were made, I was exceedingly reluctant to admit that *Uranus* had any appreciable compression. To me it always seemed a perfectly round disc. Yet, in 1877, Prof. Safarik says of the disc, "certainly elliptical"; and in 1879, "decidedly elliptical." In the case of *Jupiter* and *Saturn*, I recognize the compression as soon as I glance at the image in the field of the telescope. Perhaps my failure to detect the compression of *Uranus* is due to the general effect on the eye produced by its greatly reduced size, compared with *Jupiter* and *Saturn*. Taking all my measures into the account, there appears a compression, nearly the same as that found by Schiaparelli. If I neglect the four extreme measures, the compression is reduced to $\frac{1}{47}$. I must confess that I can have little confidence in so large a value of the compression; and for several reasons — 1. I have never seen the planet present any other outline than that of a perfect circle. 2. Difference of one or two-tenths of a second of arc are very likely to occur in the mean of different series of micrometer measures; and even so small a difference is a very large per cent. of the semi-major axis of the disc. 3. Add to this the consideration that some of the most carefully conducted measures show a compression so small as to be practically inappreciable.

RESULTS OF MEASURES, 1877.

Date.	$P=0°$, Dir. of Decl. Circle.		No. Obs.	$P=90°$, Dir. of Parallel.		No. Obs.	Log. True Distance.
	Diam. Meas.	Diam. Redu.		Diam. Meas.	Diam. Redu.		
	″	″		″	″		
1877, Feb. 6				4.197	3.802	3	1.24004
" 8	4.610	4.176	5				1.23999
" 9	4.040	3.660	4				1.23996
1877, Mar. 3				4.364	3.967	5	1.24148
" 5				4.490	4.084	11	1.24179
" 9				3.960	3.600	6	1.24250
" 13	4.267	3.895	7	4.274	3.901	6	1.24332
" 14	4.640	4.236	7	4.370	3.990	6	1.24343
1877, Apr. 13	4.410	4.111	8	4.580	4.269	6	1.25242
" 20	4.110	3.854	5	3.840	3.601	5	1.25502
" 22	4.490	4.218	7	3.940	3.701	7	1.25577
1877, May 5	4.190	3.982	6	4.030	3.831	5	1.26086
" 8	4.370	4.165	4				1.26205
" 9	3.950	3.768	6	3.750	3.579	5	1.26245
" 20	4.420	4.258	5	4.380	4.221	5	1.26676
1879, May 17	4.480	4.253	3				1.26030
Means		4.048			3.880		

Equatorial Diameter, 4″.048 ± 0″.036 Polar Diameter, 3″.880 ± 0.044

Resulting Compression, $\frac{1}{12.04}$

Neglecting the compression, the general mean is 3″.964, which differs only 0″.049, from the general mean of Prof. Seeliger.

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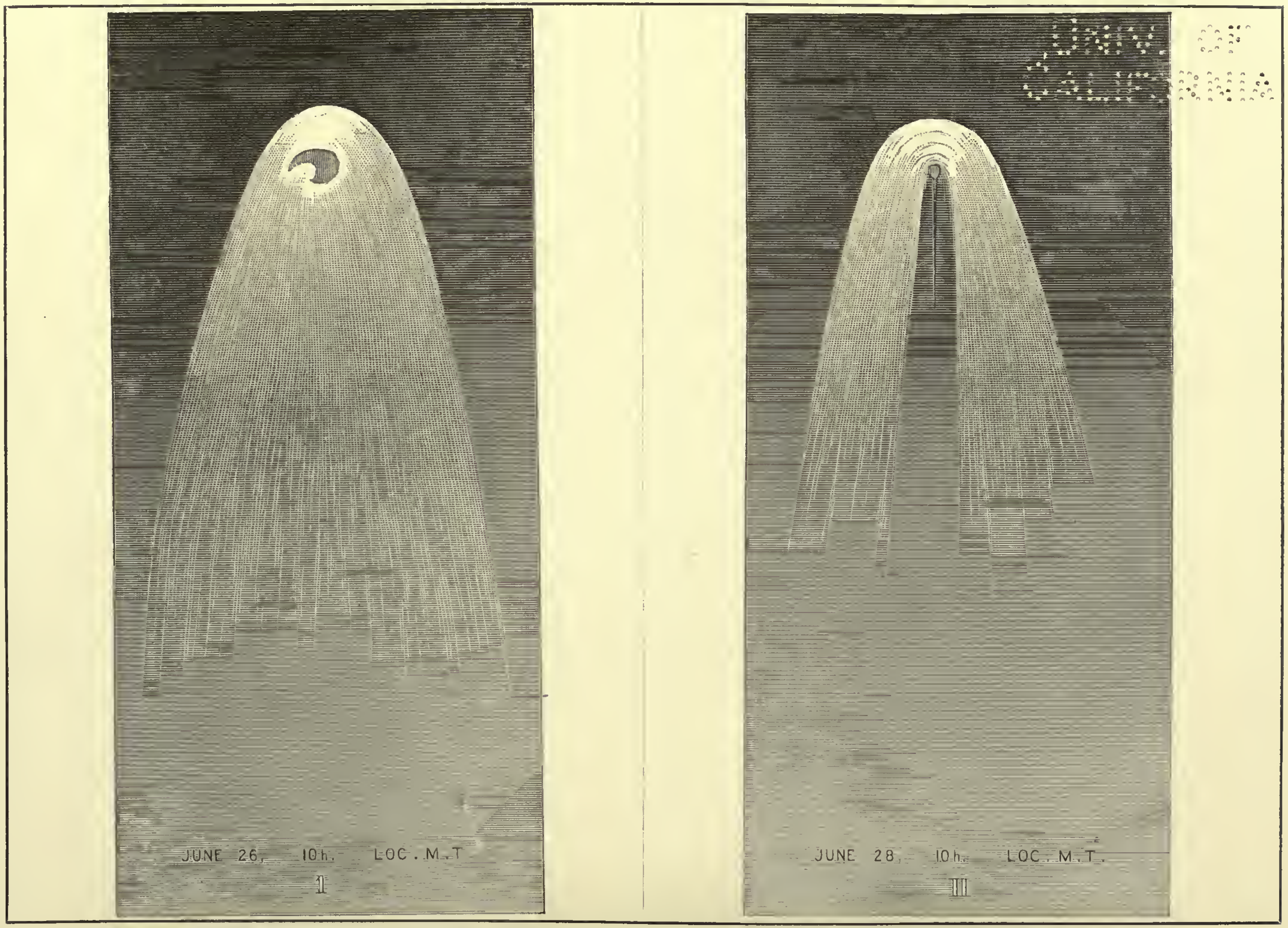

JUNE 26, 10h. LOC. M. T.
I
JUNE 28, 10h. LOC. M. T.
III

UNIV. OF CALIFORNIA

COMET HENRY (1881 *b*).

OBSERVATIONS OF COMETS.

For several years after our work began, we were precluded from active participation in the observations of comets, both by press of other work, and failure to receive astronomical telegrams announcing discovery. Under the cipher system of sending the announcing telegrams, inaugurated several years ago by the *Science Observer*, astronomical discoveries from all parts of the world are now promptly received, and work can begin at once. The center of distribution for the United States is the Observatory of Harvard College, Cambridge, Mass.; and telegrams go out under the direction of Prof. Edward C. Pickering, Director. On the continent of Europe, the center of distribution is the Royal Observatory at Kiel, and the messages go under the direction of Dr. Prof. Krüger, Director, and Editor of the *Astronomische Nachrichten*. For the British Isles, the center of distribution is the Observatory of Lord Crawford, Dun Echt, Aberdeen, Scotland.

The observations on comets, made at this Observatory during the years 1880–81, were chiefly by Prof. H. S. Pritchett. On account of his removal to St. Louis, in the autumn of 1881, some of these observations are yet unreduced; and hence few of them have been published. The observations of later comets have all been made by the Director, and have been promptly published. We can not afford the room in this volume for the publication of these observations and reductions, in detail, although they involve an immense amount of work. All we can do here is to recall the successive comets, and give a few notes concerning them.

1880, Comet Hartwig (*1880 d*). No telegraphic announcement was ever received, and only a few observations in its later stage of visibility were made. These were published in *Astronomische Nachrichten*, No. 2361. H. S. P. observer. When observed here, the comet was a faint diffused mass.

1880, Comet Swift (*1880 e*). This comet was observed from November 1 to December 9. H. S. P. observer. While the comet was always faint, it had a marked central condensation. The reductions are yet unfinished, and hence the observations have remained unpublished.

1880, Comet Pechule (*1880 f*). No announcement of discovery was received. The comet was bright and easy to observe. Observations made late, and yet unpublished.

1881, Comet Henry (*1881 b*). This comet possesses a remarkable interest, on account of the astonishing changes in its nucleus between June 26 and June 28. A sketch of the nucleus and its environment is given for June 26, and I transcribe a passage from the note book for that date.

NOTE.—"The nucleus is very sharp and star-like—in front of the nucleus the rings or envelopes are very marked, and beyond the envelopes there is a very extensive and symmetrical nebulous disposition of matter. The rear of the nucleus is distinguished by a very dark void space, extending back some distance along the axis of the tail. The tail could be distinctly traced by the naked eye 10° or 12°."

On June 28, the appearance of the nucleus is represented in sketch No. 2. The change is very marked and surprising. Instead of a star-like nucleus with two symmetrical arches or envelopes, there appears an unsymmetrical diffusion, as of gas or steam filling the spaces between the rings, and having a curving jet very prominent on the left. Very few observations were made of this comet, and none of them have been reduced or published.

1881, *Comet Schaeberle* (*1881 c*). This fine telescopic comet was observed from July 18 to September 10. I transcribe a note from the books for August 24. The observations were made in part by myself, but mostly by H. S. P.

Note. — August 24. "Nucleus very sharp and star-like. The tail extends about 5°, and is divided into three fan-like segments, parted by dark spaces. The cometic matter of same consistency as tail, is very slightly projected in front of nucleus. No rings or envelopes. A fine appearance in telescope, and very easy to observe."

As yet the observations have not been fully reduced, and therefore are unpublished.

1881, *Comet Encke*. One observation, September 20.

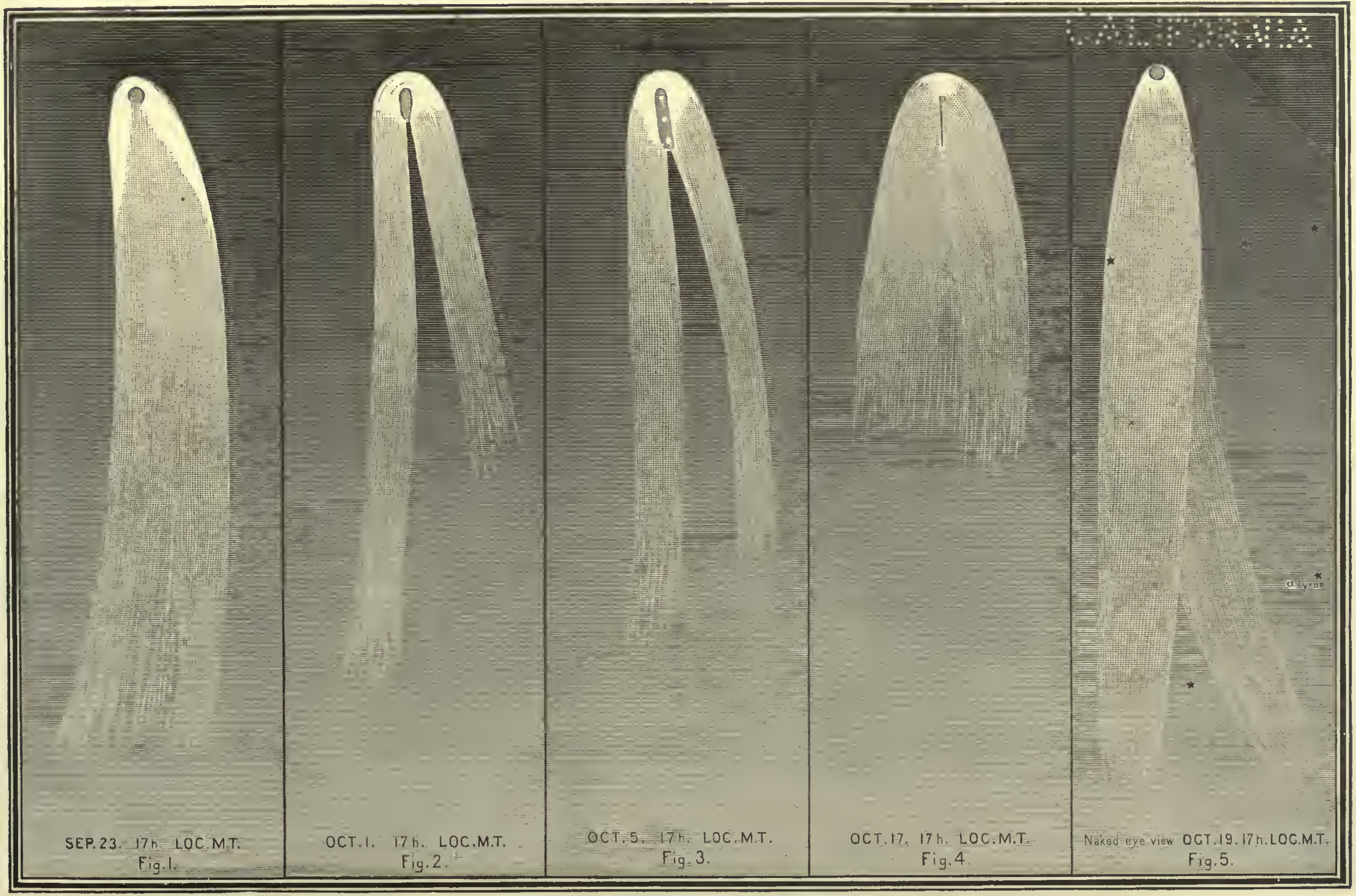
1882, *Comet Wells* (*1882 a*). The observations extend from March 31 to May 21, and are published in *Astronomische Nachrichten*, No. 2481. This comet at perihelion was very near the sun, and from theoretical considerations should have made a fine appearance to the naked eye; but from some cause it was scarcely visible at all to unassisted vision.

1882, *Comet Barnard* (*1882 c*). Observations extend from September 22 to October 14. The comet was considerably diffused, faint, and of rapid motion southward. Observations published in *Astronomische Nachrichten*, No. 2499.

1882, *Comet Cruls* (*1882 b*). Observations on this comet began in September, and were continued till March and April, and even till May 8. At this Observatory, the first observation was October 3, and the last February 3. It ranks among the great comets of the century, like Donati's comet (1858), the comet of 1843, and that of 1811. During the whole month of October it presented a magnificent spectacle in the morning sky. Two marked peculiarities distinguished it from other large comets — one the abrupt and forked termination of the tail, resembling the posterior fin of a fish; and the other its anomalous nucleus. The comet was detected by the naked eye, by M. Cruls of the Imperial Observatory, Rio Janeiro, September 11. But it had been detected September 8 by Mr. Finlay, first assistant of the Observatory at the Cape of Good Hope, and by Mr. Ellery, at Melbourne, September 7. It passed its perihelion September 17, and really passed in transit between the earth and sun. At the Cape it was followed up to the sun's limb, where it suddenly disappeared, at $4^h\ 50^m\ 58^s$, Cape M.T., thus showing, that bright as its train appeared in open daylight, the matter of the nucleus was not sufficiently aggregated to cause it to appear as a spot bright or dark while in transit across the sun's disc. That it passed through the solar corona, is well nigh certain.

The observations made here are published in *Astronomische Nachrichten*, No. 2518. On the physical appearance the following notes are taken from the books: —

September 24. At 17^h, the nucleus was observed when about 10° above horizon. The comet has no envelopes or rings preceding the nucleus, and the coma is not protruded or diffused as in



SEP. 23. 17h. LOC. M.T. Fig. 1.

OCT. 1. 17h. LOC. M.T. Fig. 2.

OCT. 5. 17h. LOC. M.T. Fig. 3.

OCT. 17. 17h. LOC. M.T. Fig. 4.

Naked-eye view OCT. 19. 17h. LOC. M.T. Fig. 5.

COMET CRULS (1882 *b*).

many comets. The nucleus is very round and planet-like. In size it is a little larger than *Uranus*. A dark stripe in center of tail is very distinct. Sketch No. 1 shows its appearance at this time.

September 25. The nucleus and environment again sketched, at 17^h 15^m. The nucleus still round, but apparently larger and less sharp than on September 24.

October 1. The comet was sketched as shown in No. 2. The nucleus elongated in the direction of the axis. Shape of nucleus almost cylindrical. Two bright points in the elongated cylinder.

October 4. The nucleus was observed to be still further elongated, and there are three points much brighter than others. It resembles a long loose filament with three distinct knots. The bright points appear on the same line, as so many bright knots connected by a nebulous ligament. They are not distinctly separated. Sketch No. 3 represents the head of the comet, as seen in the telescope.

October 5. The nucleus is indeed a mystery. The elongation still increases. The three centers of light are situated in a line extending through the axis of the tail. In comparing with stars on micrometer, used the middle point. The observations made in twilight without artificial illumination of threads.

October 19. Sketch No. 4 presents a naked eye view of the comet as seen at 16^h 30^m, L.M.T. It would seem as if the divisions of the tail were situated in different planes, and partially overlapped, as seen from the earth.

November 13. Several bright points are still recognized in the apparent nucleus. They are not seen constantly, but appear as glittering points in a cloud of white dust. As it is difficult to keep the track of them while passing through the field with slightly illuminated wires, the observations must suffer in precision. The nucleus still appears needle-like in shape.

1883, January 1. In the absence of the moon, the tail of the comet is still quite plain to the naked eye, while the nucleus is not distinguishable from the tail. In the telescope the apparent nucleus still preserves the elongated, needle-like shape, with several points of faint condensation, which are exceedingly difficult to follow under any artificial illumination.

January 13. When the comet crossed the meridian the tail was almost vertical. The star, o^1 *Canis Majoris*, was situated directly in the tail, which extended up under the bright star, γ *Canis Majoris*, on the margin of the milky way. The comet is changing declination very slowly, and this together with the indefinite and elongated nucleus, tends to make the micrometer readings somewhat contradictory.

January 28. The nucleus still greatly elongated; but the filamentous or horse-tail appearance has much faded out. The points of condensation still appear as white points in a cloud of dust.

In the *Astronomische Nachrichten*, No. 2499, the late Dr. Julius Schmidt, of Athens, gives a description and sketch of the apparent nucleus of this comet, as seen by him October 3. Under a high power, and after repeated effort, he was sure that he detected the true nucleus at the end of the elongation most distant from the sun. He saw it on that night only, and failed entirely, even under favorable conditions, to see it afterward. With low powers he thought that the brightest part of the elongation, or fan, was next the sun, and that this part would be fixed on for comparison with stars. If his view is correct, then nearly all the observations on this comet give the places not of the nucleus, but of a point in the projection or fan. Comparing my sketch of October

1 with that of Schmidt for October 3, the general similarity of the elongation is manifest; but I saw no reason, whatever, to conclude that the western end of the elongation was any more the nucleus than the eastern end. I used a power of 175, and the full aperture of the instrument.

1883, Comet Swift-Brooks (1883 a). Observations extend from Feb. 26 to April 9, and are published in *Astronomische Nachrichten*, No. 2517. The comet was sufficiently bright to observe in strong moonlight, and had central condensation.

1883, Pons-Brooks (1883 b). Observations extend from September 24 to February 1, and are published in *Astronomische Nachrichten*, No. 2591; also comparison with ephemeris of Schulhof and Bossert, *Astronomische Nachrichten*, Nos. 2546–2558–2569. Return of comet Pons of 1812. This comet was visible to the naked eye as a haze-enveloped star.

1884, Comet Barnard (1884). Observations extend from July 26 to October 18. Published in *Astronomische Nachrichten*, No. 2641. Comet diffused, and had numerous points of brightness.

1884, Comet Wolf (1884). Observed from September 24 to March 19. Published in *Astronomische Nachrichten*, No. 2664. Bright telescopic comet, and easy of observation.

1885, Comet Barnard (1885 c). Observations extend from July 13 to August 10. Published in *Astronomische Nachrichten*, No. 2690. Generally faint and difficult.

1885, Comet (Fabry). Observations from December 23 to January 6. Quite easy to observe; but the weather sadly interfered with the observations. Observations ready for publication.

1886, Comet Barnard. Comet quite faint, but easy to observe in the absence of the moon. Observations few in number, on account of bad weather. Observations ready for publication.

EQUATORIAL CONSTANTS.

When our equatorial was mounted in 1875, the usual cautions were observed to secure a proper elevation of the polar axis, and to place it in the plane of the meridian. After using the instrument nearly two years, several series of observations were made on stars when near the meridian, in order to determine the co-ordinates of the instrumental pole. Denoting the angular distances of the pole of the instrument, from the six-hour circle, and from the meridian, respectively, by ξ and η, we have $\xi = \gamma \cos. \vartheta$, $\eta = \gamma \, sin. \vartheta$, where γ and ϑ are the angular distance and hour angle of the instrumental pole, relatively to the true pole and the meridian. As shown in works on practical astronomy, the equations resulting from the observations not only suffice to determine ξ and η, and thence γ and ϑ, but in addition, what are called the constants of the instrument, denoted by c, $90 - i$, e, ε, Δt and Δd, and meaning in order, the collimation error, the angle between the polar and declination axes, the flexure-coefficients of the tube and the declination axle, and the index-errors of the hour and declination circles. As we rarely use an equatorial to determine absolute hour angles and declinations, but only to measure small differences in right ascension and declination, or to measure the position angle and distance of two stars near together; and further, since the weight of a large equatorial, and the excessive changes of temperature to which it is subject, are constantly altering its errors, it seems of little use to determine them. The values, however, of γ, ϑ, i and e, from the structure of the instrument, have more permanency than the rest, and their determination not only possesses a theoretical, but also a practical interest.

In the following series the bisections and transits were observed by myself, and the times were noted and the circles read by Henry S. Pritchett. While the number of observations is too small to furnish a consistent mean value for the co-ordinates γ and ϑ, still the work done may serve to show approximately the errors of the equatorial mounting.

OBSERVATIONS FOR DETERMINING ξ AND e.

These observations were made very near the meridian, so that the first observation always denotes the mean declination reading before culmination, and the second the same quantity after culmination and the reversal of the instrument (*Chauvenet's Spher. Ast.*, Vol. II., Art. 252). For stars below the pole, the supplement of δ is used. The readings of both verniers are given.

FIRST SERIES.

Date.	Star.	Circ. Prec.	Circ. Foll.	App. Inst. Dec.	M. Ref.	$D.$ = Cor. Inst. Dec.	δ	$D-\delta$	$\phi-\delta$
1877.		° ′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	″	° ′ ″
Nov. 2	α Cassi.	34 12 15 214 11 45	145 52 30 325 53 30	55 50 30	+17.3	55 52 18.1	55 52 18.1	—90.8	—16 38 32.5
2	ε Pisci.	82 49 30 262 49 00	97 15 00 277 16 00	7 13 7.5	—36.4	7 12 31.1	7 14 7.9	—96.8	31 59 37.7
2	Pol. u.c.	1 25 30 181 24 45	178 39 15 358 40 0	88 37 15.0	67.9	88 38 23.0	88 39 41.5	—78.5	—49 25 55.9
2	o Pisci.	81 30 45 261 30 30	98 33 30 278 34 30	8 31 48.75	—34.4	8 31 14.3	8 32 45.3	—91.0	30 41 0.3
2	α Arietis	67 11 00 247 10 00	112 54 00 292 55 00	22 52 00	—17.0	22 51 43.0	22 53 17.0	—94.0	16 20 28.6
2	ι Cassi.	23 13 15 203 12 15	156 51 15 336 52 15	66 49 30	30.5	66 50 0.5	66 51 17.0	—76.5	—27 37 31.4
2	α Persei	40 39 00 320 38 00	139 26 15 319 27 0	49 24 3.75	10.4	49 24 14.0	49 25 39.0	—85.0	—10 11 53.4

SECOND SERIES.

Date.	Star.	Circ. Prec.	Circ. Foll.	App. Inst. Dec.	M. Ref.	$D =$ Cor. Inst. Dec.	δ	$D-\delta$	$\phi-\delta$
1877.		° ′ ″	° ′ ″	° ′ ″	″	° ′ ″	° ′ ″	″	° ′ ″
Nov 23	γ Pegasi	75 33 00 255 32 15	104 31 00 284 32 00	14 29 26.2	—26.8	14 28 59.40	14 30 29.2	—89.8	24 43 17.0
23	α Cassi.	34 12 00 214 11 15	145 52 15 325 53 15	55 50 33.75	17.3	55 50 51.00	55 52 22.7	—91.7	—16 38 37.0
23	Gr. 4163	16 20 15 196 19 15	163 43 30 343 44 30	73 42 7.5	40.0	73 42 47.5	72 44 12.3	—84.8	—34 30 26.0
23	β Ceti.	108 41 45 288 40 45	71 22 45 251 23 45	—18 39 0.0	—92.5	—18 40 32.5	—18 39 22.5	—70.0	57 53 8.0
23	ε Pisci.	82 48 15 262 47 30	97 14 45 279 15 45	7 13 41.25	—36.4	7 13 4.8	7 14 7.5	—62.7	31 59 39.0
23	α Arietis,	67 9 30 247 10 30	112 54 00 294 54 45	22 52 11.25	—17.0	22 51 54.2	22 53 18.3	—84.1	16 20 28.0
23	ι Cassi.	23 12 45 203 12 00	156 50 45 336 51 45	66 49 26.25	30.5	66 49 56.7	66 51 23.6	—86.9	—27 37 8
23	β U. Min. s.p.	164 45 00 344 15 00	15 19 45 195 19 00	105 17 11.25	2 10.2	105 19 21.4	105 20 59.3	—97.9	—66 7 13

The type form of the equations of conditions formed from the quantities thus derived from observation is, $\xi + e \sin(\phi - \delta) = D - \delta$. The value of the latitude, $= \phi = 39° 13' 45''.6$.

EQUATIONS OF CONDITION, ξ AND e.

FIRST SERIES.

α Cassiopaeiæ	$\xi - 0.286\, e + 90.8 = 0$
ε Piscium	$\xi + 0.530\, e + 96.8 = 0$
α U. Min. u.c.	$\xi - 0.760\, e + 78.5 = 0$
o Piscium	$\xi + 0.510\, e + 91.0 = 0$
α Arietis	$\xi + 0.281\, e + 94.0 = 0$
ι Cassiopaeiæ	$\xi - 0.464\, e + 76.5 = 0$
α Persei	$\xi - 0.177\, e + 85.0 = 0$

SECOND SERIES.

γ Pegasi	$\xi + 0.418\, e + 89.8 = 0$
α Cassiopaeiæ	$\xi - 0.256\, e + 91.7 = 0$
Groomb. 4163	$\xi - 0.566\, e + 84.8 = 0$
β Ceti	$\xi + 0.847\, e + 70.0 = 0$
ε Piscium	$\xi + 0.530\, e + 62.7 = 0$
α Arietis	$\xi + 0.281\, e + 84.1 = 0$
ι Cassiopaeiæ	$\xi + 0.464\, e + 86.9 = 0$
β U. Min. s.p.	$\xi - 0.914\, e + 97.9 = 0$

RESULTING NORMALS.

$$7\,\xi - 0.366\, e + 612.6 = 0$$
$$-0.366\,\xi + 1.526\, e - 12.042 = 0$$

Whence, $e = -13''.265$ with the weight 1.507
$\xi = -88''.208$ with the weight 6.913

Probable error of $e = \pm 2''.397$
Probable error of $\xi = \pm 1''.119$

RESULTING NORMALS.

$$8\,\xi - 0.124\, e + 667.9 = 0$$
$$-0.124\,\xi + 2.688\, e - 47.586 = 0$$

Whence, $e = 13''.863$ with the weight 2.688
$\xi = -83''.272$ with the weight 8.000

Probable error of $e = \pm 3''.4$
Probable error of $\xi = \pm 2''.01$

OBSERVATIONS FOR DETERMINING η, AND c AND i.

The auxiliary quantity η is found by comparing the instrumental hour angles of two stars of widely different declination, when very near the meridian, with the observed clock times of their transit over a fixed declination thread. To eliminate the effects of error, arising from the non-adjustment of the thread to the optical axis of the instrument, the following method is pursued:—After the first transit is observed, and time noted and hour circle read, the thread is revolved 180°, and a second reading made of the time and hour circle. The instrument is then reversed, and a like pair of readings made on the same star. Denoting the first and second positions of the thread by a and b respectively, we take the mean of the readings of a and b for each position of the instrument—circle preceding and circle following, and the mean of these means, for the meridian transit—the observations having been made very near the meridian, and on opposite sides of it.

OBSERVED QUANTITIES FOR η.

FIRST PAIR.

Date	Star.	Clock Times.	Means.	Hour Circle.	Means.	α	δ
1877. Nov. 15	γ Ceti			Mean of Verniers.			
		h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	° ′ ″
	Circ. Prec. a b	2 24 8.80 2 27 10.15	T_1 = 2 25 39.47	23 48 49 23 51 6	t_1 = 23 49 57.5	2 37 0.16	2 43 25.2
	Circ. Foll. b a	2 43 5.35 2 46 23.10	T_2 = 2 44 44.22	24 6 30 24 10 8	t_2 = 24 8 19.0		
			T_0 = 2 35 11.84		t_0 = 23 59 8.2		
Nov. 15	48 Cep. (II)					α'	δ'
	Circ. Foll. a b	2 58 51.66 3 1 20.90	T_2 = 3 0 6.28	23 56 16.0 23 57 13.0	t_2 = 23 56 44.5	3 4 58.66	77 17 10
	Circ. Prec. b a	3 11 10.96 3 12 41.98	T_1 = 3 11 56.47	24 8 2 24 9 6	t_1 = 24 8 34		
			T'_0 = 3 6 1.37		t'_0 = 24 2 34.2		

The type form of the equation for η is $\eta\ (\tan\delta - \tan\delta') = T_0 - T'_0 - (t_0 - t'_0) - (\alpha - \alpha')$

Solving, with the values found in the table above, $\eta = -9^s.122$.

Combining this value of η with the values of ξ previously found, we derive

$$\vartheta = 237^\circ\ 11'\ 40'', \text{ and } \vartheta = 238^\circ\ 44'\ 40''; \quad \gamma = 162''.81, \text{ and } \gamma = 160''.18.$$

These values show that the instrumental pole was situated in the third quadrant of hour angles; or below the true pole, and east of the meridian.

OBSERVED QUANTITIES FOR η.

SECOND PAIR.

Date.	Star.	Clock Times.	Means.	Hour Circle.	Means.	α	δ
1877. Dec. 7	λ Aquarii			Mean of Verniers.			
		h. m. s.	h. m. s.	h. m. s	h. m s	h. m. s.	° ′ ″
	Circ. Foll. a b	22 39 13.3 22 41 50.8	T_2 = 22 40 32.05	23 54 0.01 23 56 45.0	t_2 = 23 55 22.75	22 46 15.15	— 8 13 42.0
	Circ. Prec. b a	22 46 50.4 22 49 16.0	T_1 = 22 48 3.2	24 1 53.5 24 4 24.5	t_1 = 24 3 9.00		
			T_0 = 22 44 17.62		t_0 = 23 59 15.87		
Dec. 7	γ Cephei						
	Circ. Prec. a b	23 22 41.6 23 25 12.9	T_1 = 23 23 57.25	23 51 33.50 23 53 10.50	t_1 = 23 52 22.00	α' 23 34 19.93	δ' 76 7 26.9
	Circ. Foll. b a	23 34 42.3 23 37 45.9	T_2 = 23 36 14.2	24 2 59.5 24 5 4.0	t_2 = 24 4 1.75		
			T'_0 = 23 30 5.67		t'_0 = 23 58 11.87		
Dec. 7	ω Piscium	(THIRD PAIR.)					
	Circ. Foll. a b	23 45 29.2 23 47 56.2	T''_2 = 23 46 42.7	23 53 33.5 23 56 13.0	t_2 = 23 54 53.25	α'' 23 53 3.38	δ'' 6 11 23.3
	Circ. Prec. b a	23 54 13.6 23 56 44.8	T''_1 = 23 55 29.20	24 2 27.5 24 5 11.0	t''_1 = 24 3 49.25		
			T''_0 = 23 51 5.95		t''_0 = 23 59 21.25		

Solving the type equations, $\eta\ (tan\ \delta - tan\ \delta') = (T_0 - T'_0) - (t_0 - t'_0) - (\alpha - \alpha')$

$\eta\ (tan\ \delta' - tan\ \delta'') = (T'_0 - T''_0) - (t'_0 - t''_0) - (\alpha' - \alpha'')$ with the values above—

We find $\eta = -17^s.50$, and $\eta = -17^s.45$, mean $-17^s.47$

Whence, We find $\vartheta = 251° 21' 50''$, and $\vartheta = 252° 22' 20''$

We find $\gamma = 275''.91$ and $\gamma = 274''.98$

While there is considerable numerical difference in the values of ϑ and γ on the different dates, the testimony of the observations is uniform, that the pole of the instrument was below the pole of the heavens, and east of the meridian, and distant from the true pole about three minutes of arc.

PUBLISHED OBSERVATIONS AND NOTES.

The papers referred to in the following list, have been published from time to time by those connected with the Observatory.

[Reference is made to the *Astronomische Nachrichten*, by the letters *A. N.; Monthly Notices*, of the Royal Ast. Society, by *M. N.; Observatory* (begun in 1878, London), by *Ob.; American Journal of Science*, by *A. J. S.; Kansas City Review*, by *K. C. R.* Other papers and journals by names.]

1876–77. September 27–January 2. Observed conjunctions of satellites of *Saturn* with each other, and with the ends of the ring and the edge of the ball. *A. N.*, 2131. C. W. P.

1877. August 28–September 28. Observations of satellites of *Mars*. *A. N.*, 2172. H. S. P. Also reference to same, in Prof. Hall's *Memoir on the Orbits of the Satellites of Mars.*

1877. October 2–December 20. Conjunctions of satellites of *Saturn* with each other, with ends of ring and edge of the ball; also measures of position angle and distance of satellites from center of planet. *A. N.*, 2189. C. W. P. and H. S. P.

1878. Measures of the companions of *Sirius*. *A. N.*, 2208. C. W. P.

1877. September 15–October 31. Diameter and mass of *Mars*, from observations made at the opposition of 1877, by C. W. P. *A. N.*, 2232. H. S. P.

1878. August 15–December 6. Conjunctions of the satellites of *Saturn* with each other, and with the ends of the ring and the edge of the ball. *A. N.*, 2264. C. W. P.

1879. November 27. Method of observing the times of central transit of the disc, by the red spot on *Jupiter*. *A. N.*, 2294. C. W. P.

1879. October 19–November 30. Observations of satellites of *Mars*, *Deimos* and *Phobos*. *A. N.*, 2307. C. W. P.

1879. October 27–November 27. Micrometer measures of diameters of *Mars*, made by C. W. P.; reduced by H. S. P. *A. N.*, 2309. H. S. P.

1879. September 12–December 12. Conjunctions of satellites of *Saturn* (observed). *A. N.*, 2314. C. W. P.

1879. November 1–6. Observations of Comet Hartwig. *A. N.*, 2361. H. S. P.

1882. March 3–May 12. Observations of Comet Wells. *A. N.*, 2481. C. W. P.

1882–83. October 3–January 28. Comet 1882 II. *A. N.*, 2515. C. W. P.

1881–82. Results of measures of diameters of *Mars*. *A. N.*, 2652. C. W. P.

1882. September 22–October 14. Comet 1882 III. Barnard. *A. N.*, 2499. C. W. P.

1883. February 26–April 9. Comet Brooks-Swift. *A. N.*, 2591. C. W. P.

1884. Note on the latitude of MORRISON OBSERVATORY. *A. N.*, 2625. C. W. P.

1884. Comet Barnard. *A. N.*, 2641. C. W. P.

1884–85. Comet Wolf. *A. N.*, 2664. C. W. P.

1883–84. September 21–February 1. Comet Pons-Brooks. *A. N.*, 2591. C. W. P.

1885. Comet Barnard. *A. N.*, 2690. C. W. P.

1879. Markings on *Jupiter*, giving first published account of red spot, with a sketch. *Ob.*, No. 21.

1879. Transparency of the atmosphere at high altitudes. From data gathered during the solar eclipse expedition to the upper valley of the Arkansas, July, 1878. *Ob.*, No. 21.

1879. Account of observations of transit of *Mercury*, May 6–7, 1878. *Ob.*, No. 17.

1879. October 30. The red spot on *Jupiter*. List of times when it eluded observation. *Ob.*, No. 30.
1879. Motion of the spots on *Jupiter*. *Ob.*, No. 34.
1882. Occultation of *4 Geminorum* by *Jupiter*. *Ob.*, No. 68.
1885. Note on rotation of astronomical domes. *Ob.*, No. 98.
1885. The red spot on *Jupiter*. *Ob.*, No. 100.
1885. Statements and restatements concerning Jovian markings. *Ob.*, No. 103.
1878. Report on transit of *Mercury*. C. W. P. and H. S. P. Appendix II. *Washington Observations*, 1876.
1878. Report on total solar eclipse. C. W. P. and H. S. P. Vol. II. *Washington Observations*, 1876.
1879. Colors of *Mars* and *Saturn*, at their near approach, June 29, 1879. Letter to Sir Geo. B. Airy, Astronomer Royal. *M. N.*, Vol. XXXIX.
1879–80. Observations of transits of red spot across the central meridian of *Jupiter*. *M. N.*, Vol. XL.
1880–81. Observations of transits of red spot across the central meridian of *Jupiter*. *M. N.*, Vol. XLI.
1881–82. Transits of red spot across central meridian of *Jupiter*. *M. N.*, Vol. XLII.
1879. Phenomena of the red spot on *Jupiter*, and the deduced time of axial rotation of the planet, from observations made at the MORRISON OBSERVATORY, by C. W. P. Paper read before the Boston Meeting of the American Association for the Advancement of Science, 1880. Vol. I. *Proceedings*. H. S. P.
1878. Astronomical memoranda for January, 1878. *K. C. R.* C. W. P.
1878. Notes on *Sirius* and the zodiacal light, March, 1878. *K. C. R.* C. W. P.
1878. Occultation of *Venus*, 1877, December 8. *K. C. R.*, February, 1878. C. W. P.
1879. Conjunction of *Mars* and *Saturn*, June 29, 1878. *K. C. R.*, July. C. W. P.
1880. Diameters of *Mars*. *K. C. R.*, 1880, May. H. S. P.
1882. Physical changes on *Jupiter*. *K. C. R.*, February. C. W. P.
1879–80. Ephemeris of satellites of *Mars*. Opposition 1879–80. *A. J. S.* H. S. P.
1881–82. Ephemeris of satellites of *Mars*. Opposition 1881–82. *Proceedings St. Louis Academy of Sciences*. H. S. P.
1880–81. Account of the Kansas City time ball. *K. C. R.* H. S. P.
1883–84. Criticism of statements relative to change of earth's axis. *K. C. R.* H. S. P.
1885. Notes on certain reputed sun spots of 1864. *K. C. R.*, April. C. W. P.
1879. Observations of partial occultation of *Venus*. *St. Louis Christian Advocate*. C. W. P.
1882. The approaching transit of *Venus*. *K. C. Journal*.

THE NEW STAR IN ANDROMEDA.

1885, September 1. To-day, a telegram from Prof. Pickering, announced the discovery of a "star-like nucleus" in the great nebula of *Andromeda*. At $9^h.5$ the telescope was turned on the nebula, and the revelation of the instrument was indeed startling. A bright star, estimated to be of magnitude 6.5, shone with steady brightness, near the center of the ancient nebula, in a space hitherto apparently untenanted except by the nebulous mist. Preceding it about 1′, but not exactly on the same parallel, was a fainter white star also within the nebulous limits. The *Nova* to-night seemed to shine with a sharp, steady ray, utterly free from any nebulous haze.

1885, September 13. The night was very fine. Prof. Henry S. Pritchett of Washington University was present. Little change in the appearance of the *Nova*, except that it is certainly less bright, and not quite so sharp as on September 1. A faint star-like point was detected about 10″ from the *Nova*, and following it almost on the same parallel. The eye-pieces were turned and changed several times, to be sure of its objective reality. It has the appearance of a companion to the *Nova*, and in any other place would be so considered. I can see no good reason for calling it "a nucleus," for it is entirely star-like, and about as bright, apparently, as the outer satellite of *Mars*.

1885, October 6. The new star is certainly fading fast. The night fine for seeing. The *Nova* is perhaps not brighter than magnitude 9, and appears enveloped in a haze. The star-like point, noted September 13, is still more plainly visible to-night, 10″ following the *Nova*.

1885, October 29. The *Nova* is fading very fast. Present magnitude 10 or 10.5. The seeing very fine. Examined very carefully to-night the "boundaries" of this ancient nebula. In a large instrument, and under good atmospheric conditions, it certainly has not that regularity of outline assigned to it in many drawings. Its extent is a surprise. There are at least three filamentous branches, which do much to impair its general symmetry of outline. The faint companion of the *Nova* is still distinctly seen.

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